FEBRUARY, 1961

TRAFFIC ENGINEERING

- The Toronto Pedestrian Crossover Program
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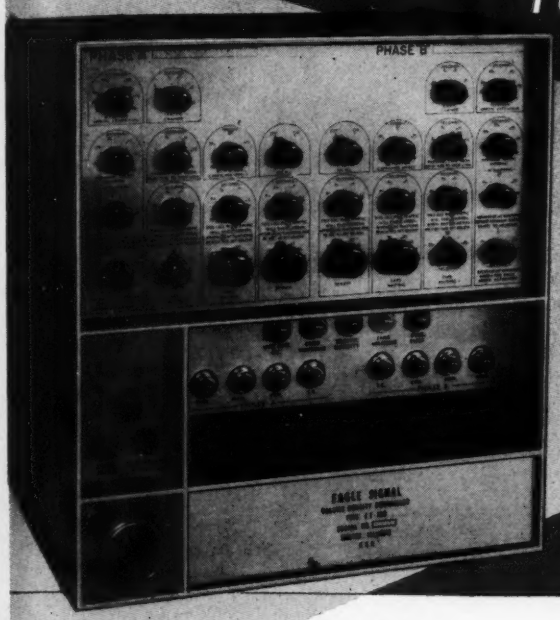

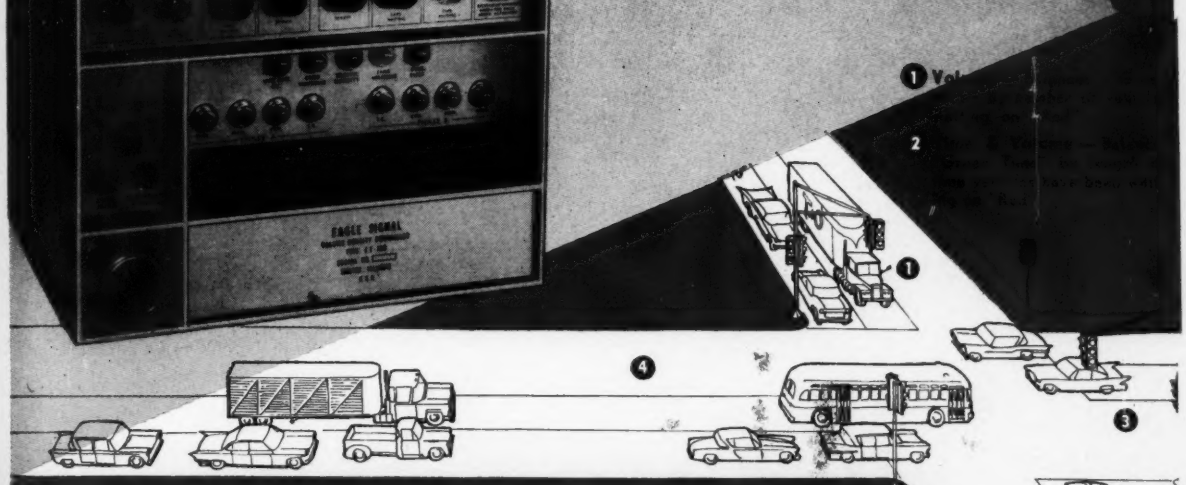

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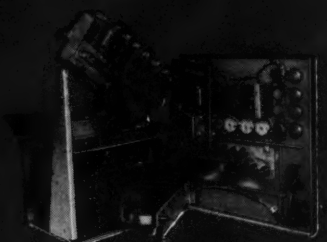

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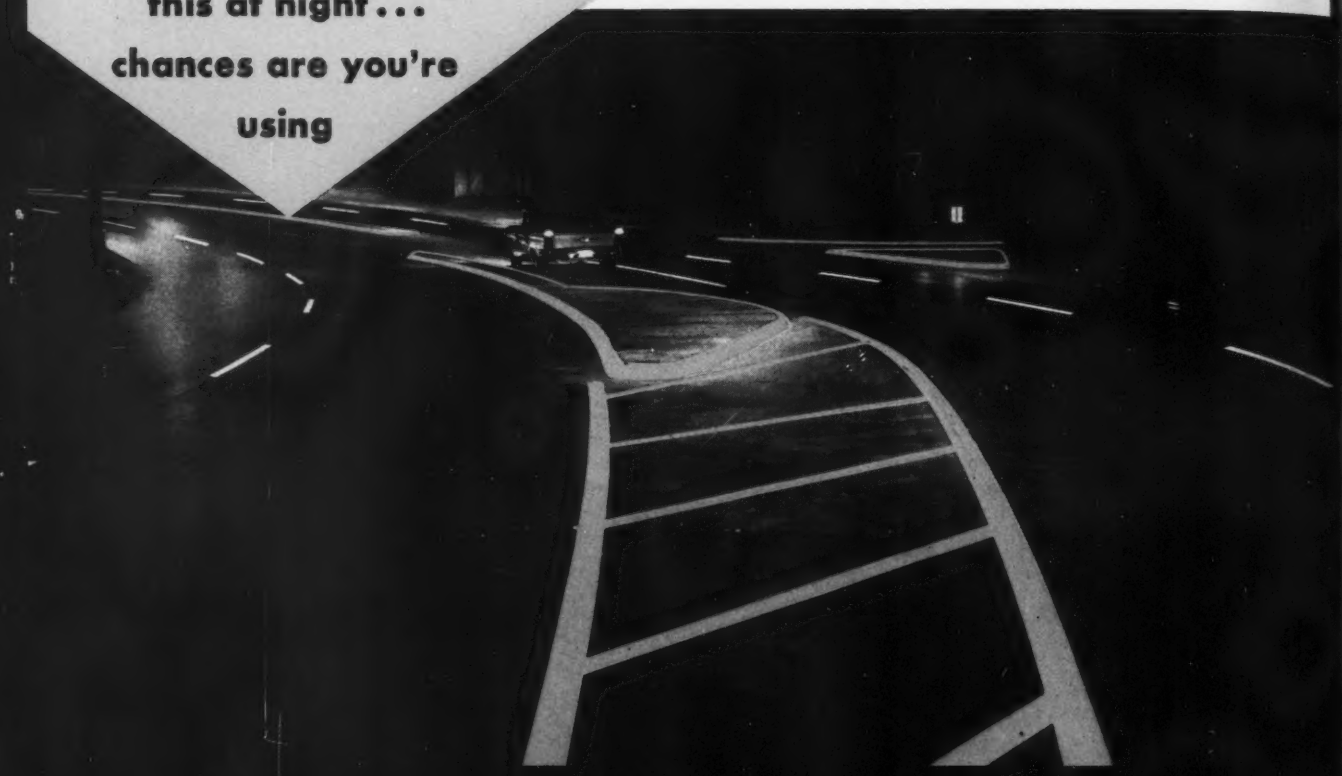

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Cover: Road of the Future?—A section of highway with all possible roadside hazards set back at least 100 feet from the edge of the pavement and with flat slopes to provide "recovery space" for a driver who goes out of control. This is a section of the new "Ride and Handling Loop" at the General Motors Proving Ground at Milford, Michigan, built to test among other things the theory that a wide, flat cross-section without any obstructions will greatly increase the safety of a highway.

—Photo from GM Proving Ground.

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Frankly Speaking . . .

THE TRAFFIC ENGINEER, in a great majority of our cities, has to be an expert in public relations, a clearing house for ideas and requests, a public speaker for many types of traffic meetings and an engineer with the technical knowledge, honesty and integrity to solve traffic problems and promote traffic safety.

He has an extremely rough road to travel especially in those communities in which the city council or aldermen have the final say-so as to how traffic shall be handled.

The councilman brings his requests to the traffic engineer usually from small pressure groups. These groups are not interested in the safe, efficient movement of traffic but only in the results accruing to their benefit. It only takes one or two calls from a constituent to his councilman for a traffic light or a 4-way stop to become a major issue on the council floor. The traffic engineer can present facts, figures and proof that the light or stop is not warranted. Then the councilmen get together, behind the scenes, and after some horse-trading they pass the ordinance over the objections of the traffic engineer. This system defeats the entire program of good traffic engineering for the simple reason that the change will help a few and be a detriment to the great majority.

The easy way for the traffic engineer would be to say "Yes" to everybody, yet he must be courageous and give a firm "No" when the facts show the change would not be beneficial to the general public. He must be tactful and diplomatic, using every convincing argument at his disposal to convince the councilman or his constituents that putting up traffic control devices without adequate study is apt to create disrespect for other traffic regulations. This is especially true in the number of requests received for 4-way stops. If every request were honored, we would have an immediate increase in violations.

On the other hand the engineer cannot disregard public sentiment for changes which will better the traffic flow or promote traffic safety. He cannot be obstinate, yet he should never jeopardize his principles to gain some temporary popularity.

Since traffic is a major problem in our cities, we need a reappraisal of how best to cope with this ever increasing enigma. The best approach to the subject would be to remove traffic matters from the hands of the politicians and give to the traffic engineers the right and power to do the job. This has happened in a few cities and reports indicate excellent results. When traffic changes are made by qualified persons and those changes are based on fact and adequate study it stands to reason that these changes would be better than those based on merely "We need it" or "I've just gotta have it."

HERBERT B. WOODLING
Director, District 3,
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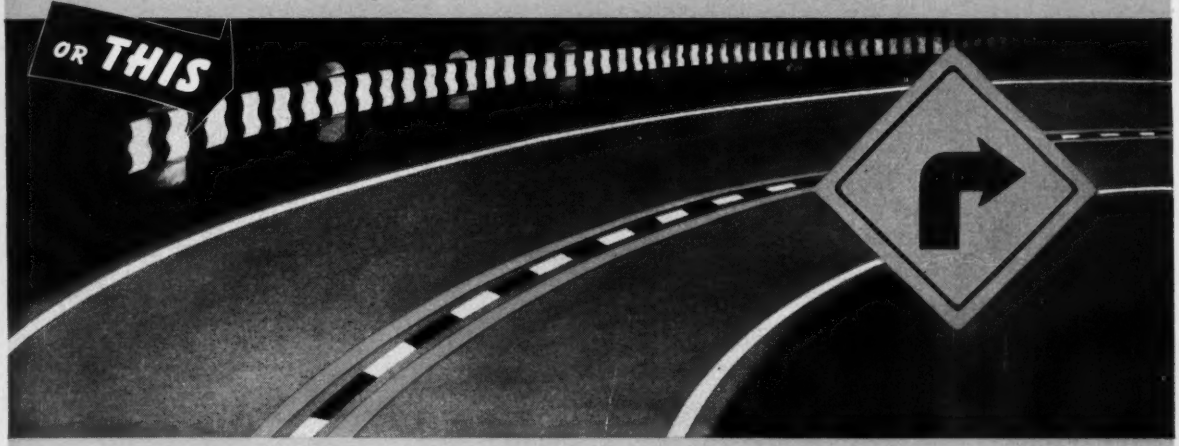

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The Toronto Pedestrian Crossover Program

By Morris Rotman
Accident Analysis Engineer
Traffic Division
Toronto Department of Public Works

In 1958, pedestrian crossovers were introduced in Metropolitan Toronto. Since that time there has been much controversy regarding their operation and safe usage. This report outlines the development, the considerations regarding operation, and the effectiveness of pedestrian crossovers from a safety and efficiency standpoint.

Development of the Pedestrian Crossover

Prior to the introduction of pedestrian crossovers, painted crosswalks had been in use for several years. Due to general abuse by motorists, inadequate legislation and the difficulty of enforcement, crosswalks were not effective in helping pedestrians to cross busy arteries.

For several years, the Pedestrian Protection Committee of the Ontario Traffic Conference (an association of municipal officials having to do with traffic) had under consideration the question of the inadequacy of the Ontario Highway Traffic Act, with respect to the rights and duties of pedestrians. Representations were made to the Ontario Government on the subject, with the request that a study be made and appropriate legislation adopted. About the same time, certain members of Toronto City Council were pressing for some solution to the problem of getting pedestrians across busy traffic arteries.

As a result of these various representations, a draft by-law for the use of municipalities was prepared in the spring of 1958, by the Ontario Department of Transport. This bylaw formed the basis for concerted action by all the municipalities of Metropolitan Toronto. As a result, uniform bylaws were adopted by the fourteen councils involved, with approval to the end of 1960, by the Ontario Department of Transport. The crossover program officially went into effect on September 15, 1958.

According to this by-law, a pedestrian crossover is defined as "any portion of a roadway at an intersection or elsewhere, distinctly indicated for pedestrian crossing by signs and by lines or other markings on the surface."

To clearly define driver and pedestrian rights and duties on the streets, the following sections were incorporated in the bylaw.

1. (a) Except where traffic control signals are in operation or where traffic is being controlled by a police officer, the driver of a vehicle or streetcar on a road, shall yield the right-of-way to every pedestrian upon a pedestrian crossover, stopping if need be to so yield, but no pedestrian shall suddenly leave the curb or other place of safety and walk or run into the path of a vehicle or streetcar which is so close that it is impossible for the driver to yield.

(b) When a vehicle or streetcar is stopped at a pedestrian crossover to permit a pedestrian to cross the roadway, the driver of any other vehicle or streetcar approaching from the rear shall not overtake and pass the stopped

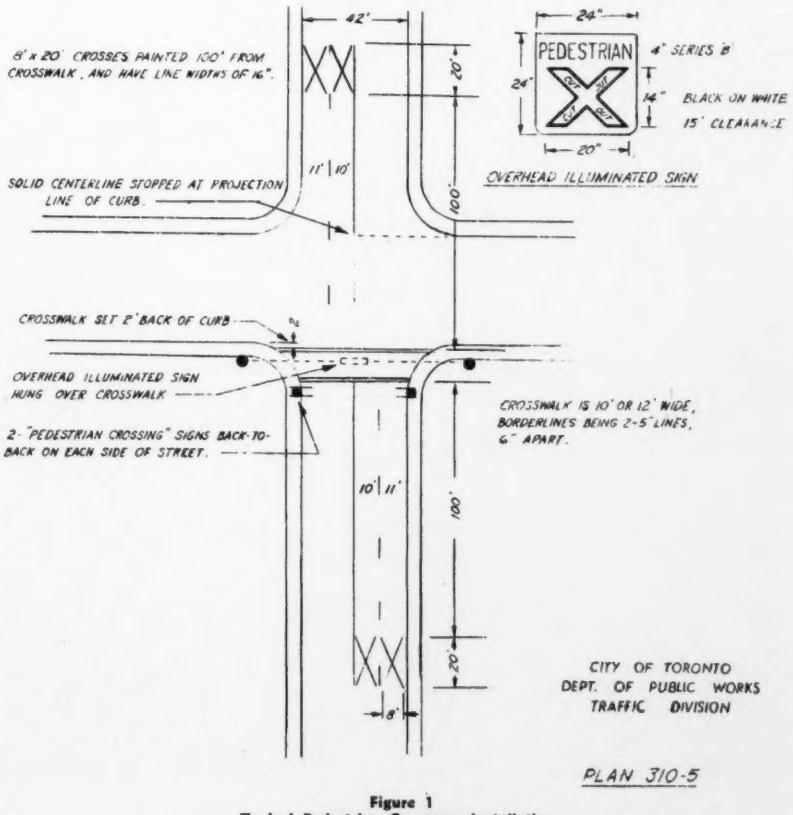

Figure 1
Typical Pedestrian Crossover Installation

Figure 2
Pedestrian Crossover Sign

vehicle or streetcar.

2. Except where traffic control signals are in operation or where traffic is being controlled by a police officer, a pedestrian crossing a road at a place other than a pedestrian crossover shall yield the right-of-way to all vehicles and streetcars upon the roadway, but nothing in this section shall relieve the driver of a vehicle or streetcar from the obligation of taking all due care to avoid an accident.

It should be stressed that the pedestrian crossover was not introduced primarily as a means of reducing accidents. It was conceived as a traffic control device which would afford pedestrians a means of crossing heavy traffic arteries, and at the same time, creating as little delay as possible to vehicular traffic.

Basically, the pedestrian is expected to utilize a gap in vehicular traffic, if such exists, to commence a crossing, and having stepped into the roadway he then has the right-of-way to enable him to complete his crossing. If no gap exists, a pedestrian, by cautiously stepping off the curb, will create a stoppage of traffic sufficient to permit a safe crossing.

When established on September 15, 1958, each pedestrian crossover installation consisted of a sign for each approach direction, mounted at the edge of the pavement, and markings indicating the boundaries of the crossing area.

Early Operation

In the first week of crossover operation one pedestrian was killed and several injured in pedestrian crossovers. This led to an immediate reassessment of the crossover program. It was decided that pedestrian crossovers should be retained, but to increase the safety and efficiency, the following changes were made at each crossover location:

1. Two signs for each approach direction mounted at the edge of the pavement.
2. Double crosswalk lines.
3. Advance markings 100 feet ahead of the crossover.
4. Advance warning signs where needed.
5. Lighted overhead sign above the centre of the crossover to illuminate the pavement for the full width of the crossover, and at the same time permit fast recognition because of its yellow colour.
6. No stopping regulations for 30 feet on either side of the crossover. All bus and streetcar stops relocated to conform to this regulation.

Figures 1 and 2 illustrate a typical pedestrian crossover installation.

The above signs, markings and regulations are now uniform, and are used in almost all locations throughout Metropolitan Toronto.

It should be noted that $10,000 was spent before the crossover program began to advertise their function and use to the public.

As a result of the pedestrian accidents at crossovers in the first week of its operation, a large amount of publicity appeared in the three Toronto newspapers. This had the result of making the public aware not only of the pedestrian crossovers, but also of traffic safety in general.

As a result of this safety consciousness and an intensive safety campaign, abetted by severe winter driving conditions, a significant decrease in total fatalities, total pedestrians injured, and total persons injured occurred during 1959, the first full year of pedestrian crossovers. This decrease in pedestrian and personal injury accidents occurred in spite of an overall increase in traffic accidents and an increase in vehicle registration.

Table 1 gives the accident statistics for Metropolitan Toronto, before and after pedestrian crossovers.

Safety of Pedestrian Crossovers

It has previously been stated that the pedestrian crossover was not conceived primarily as a safety device, but as a traffic control device to aid

TABLE 1

	1957 (No PXO's)	1958 (4/12 Yr. PXO's)	1959 (Full Yr. PXO's)	Change 1957-59
Total Persons Injured	6935	6443	5645	—19%
Total Fatalities	125	127	107	—14%
Total Pedestrians Injured	2317	2167	1798	—22%
Total Pedestrians Killed	85	81	71	—16%

TABLE 2

Accident Type	Before PXO		After P.X.O.			
	7 Mo. of 1958		7 Mo. of 1959		7 Mo. of 1960	
	Total	%	Total	%	Total	%
Right Angle	67	26	42	11	43	11
Rear End	46	18	180	50	221	56
Left Turn	39	15	28	8	33	8
Side Swipe	10	4	22	6	14	4
Pedestrian in PXO	—	—	39	11	47	12
Pedestrian out of PXO	57	22	18	5	17	4
Other	38	15	34	9	19	5
Total	257	100	363	100	394	100

pedestrians in crossing busy traffic arteries.

An analysis of the accidents at the original 170 PXO locations, in the city, during the first 7 months of 1958, 1959 and 1960, is shown in Table 2.

From this table it can be seen that since pedestrian crossovers have been established, there has been at these particular locations, a decrease in all types of accidents, except rear end accidents, pedestrian accidents and side swipe accidents.

It is interesting to note the substantial decrease in right angle and left turn accidents. This is due to the fact that when main street traffic stops for a pedestrian in the crossover, side street traffic has a reasonable opportunity to cross the main street. For this reason it is important to locate the crossover so as to minimize the conflict from turns.

Typical pedestrian crossover. Note bus stop located 30 feet away from crossover.
Figure 3

1. Pedestrian Accidents

It is important to note that although pedestrian accidents at crossovers have been well publicized, these accidents form only a small percentage of the total pedestrian accidents. The analysis of 910 pedestrian injuries, which occurred in the city in the first 8 months of 1960, by location reveals:

7% occurred at Pedestrian Crossovers
8% occurred at Unsignalized Intersections
16% occurred at Traffic Signals
69% occurred at Other Locations

Considering the number of pedestrian crossovers and traffic signals in the city, the pedestrian accident rate at traffic signals is nearly double the rate for crossovers.

Studies of driver observance of pedestrian crossovers have revealed that at most locations, about 80% of all drivers stop for pedestrians in the crossover. This figure includes all drivers who stopped when a pedestrian was in the crosswalk, regardless of the position of the pedestrian. In fact, the percentage of drivers who actually failed to yield the right-of-way to a pedestrian, as required by the bylaw, was much smaller than the remaining 20% indicated as failing to stop.

Some locations have driver observance of only 50% to 70%. These locations require additional enforcement, not only of driver non-observance, but also of illegal parking too close to the crossover, which is a contributing cause to the non-observance. By studies such as this, it is possible to pinpoint the locations where active enforcement may be applied to the best advantage.

Another important factor is the pedestrian observance of the crossover, i.e. whether they wait for gaps in traffic, or suddenly leave the curb, so as not to give the driver a chance to stop. It has been observed that pedestrian behaviour, while excellent at most locations, is poor at certain crossovers. For this reason, the Police Department put special emphasis in late 1959 and 1960 on enforcement of correct pedestrian duties at crossovers.

Since the crossovers have been established, there has been a one-third increase in the number of pedestrians crossing at these locations. This correspondingly increases the exposure to accidents at these locations and could account in part for the increase of 7 in the number of pedestrian accidents at these 170 crossovers.

Of 170 crossovers studied in 1960, 131 — more than three-quarters — had no pedestrian accidents.

2. Rear End Accidents

The increase in rear end accidents at crossover locations should not be considered without also considering the decrease in rear end accidents at mid-block locations. An analysis of rear

Figure 4
Typical pedestrian crossover. Note that vehicle from minor street is given opportunity to cross the main street, while traffic stops for pedestrian in the crossover.

TABLE 3

Year	Total Accidents	Pedestrian Accidents	Rear End Collisions	Accidents Excluding Pedestrian & Rear End
1957	20,328	2,257	5,723	12,348
1958	19,487	2,157	5,870	11,460
1959	22,664	1,799	6,610	14,255

end accidents between 1957 and 1959 is shown in Table 3.

If, without the crossovers, rear end accidents had increased from 1957 to 1959 in the same proportion as non-rear end collision accidents, the number of rear end collisions would have been 6,607 as compared to 6,610 which actually occurred.

Therefore, it may be assumed that the increase in rear end accidents at pedestrian crossover locations is not entirely due to the crossover itself, but is the result of a concentration of rear end accidents, which might otherwise have occurred at other locations.

A study of 29 crossovers has revealed a 34% increase in the number of pedestrians crossing at these locations. Also, it is significant that over 88% of all persons crossing, do so within the crosswalk, where formerly 50% crossed at each side of the intersection.

The increase in the number of persons crossing in the crossover, represents those people who have been attracted from mid-block crossings. This possibly accounts for the decrease in rear end accidents mid-block.

In 1959, the first full year of the crossover program, the 6,610 rear end accidents were distributed as follows: At Pedestrian Crossovers, 863—13.1%; at Traffic Signals, 1294—19.5%; at Stop Streets, 195—3.0%; at Other Locations, 4258—64.4%.

It should be noted that pedestrian crossover locations account for less than one-seventh of all rear end accidents.

According to Police records, three of the most predominant driving violations are: 1) failure to keep proper lookout; 2) driving too fast for conditions; and 3) following too closely.

These three violations constitute over 60% of all driver violations.

As long as these driver violations are prevalent, rear end accidents at pedestrian crossovers, as well as at other locations, will occur.

However, it should be noted that not all crossover locations have a high incidence of rear end accidents. Of the 170 locations studied, 46 or 27% had no reported rear end accidents at all in 1959. Less than 10% of the locations had more than 5 rear end accidents, and 80% had 3 or less rear end accidents.

Rear end accidents at pedestrian crossovers and traffic signals during 1959, in Metropolitan Toronto, compare as follows:

Total pedestrian crossovers—522
Total rear end accidents —863
An average of 1.65 rear end accidents per crossover.

Total traffic signals —548
Total rear end accidents—1294
An average of 2.36 rear end accidents per signal.

In a study of 21 traffic signal locations, the before and after accident records revealed that the number of rear end accidents occurring increased from 12 the year before, to 23 the year after.

It should be stressed here that every traffic control device has a particular purpose, either to grant right-of-way, caution traffic, aid pedestrians, or some other purpose. Although the safety record should not be looked at lightly, it should not be the sole concern.

Efficiency of Operation

(a) *Pedestrian Delay*

A study was made at pedestrian crossover locations and pedestrian-actuated signals to determine the average waiting time encountered by pedestrians.

This study was made during the morning and evening rush hours when pedestrians would be expected to have the maximum difficulty in crossing. The average time that pedestrians had to wait on the curb before crossing was 3.8 seconds at pedestrian crossovers; at pedestrian-actuated signals the average waiting time for a green signal was 34.6 seconds.

Thus, in terms of delay time to pedestrians, the pedestrian crossover is almost ten times as efficient as the pedestrian-actuated signal.

(b) *Vehicular Delay*

From speed and delay studies carried out on all major arteries in the city, it was found that the delay encountered by vehicles at pedestrian crossovers was insignificant compared to the delay encountered at other locations.

Due to the nature of the crossover, the driver may slow down in advance of the crossover to allow a pedestrian to cross, but need not necessarily stop. If a driver needs to stop at the crossover to allow pedestrians to cross, he may proceed as soon as these pedestrians have passed his side of the road.

Figure 5
View of pedestrians in a pedestrian crossover. The additional two stripes on each side of crossover are plastic markings which will give year round service.

When a driver stops at a crossover, the usual waiting time is 4 to 6 seconds.

At a pedestrian-actuated signal a driver would have to wait a minimum of 15 to 20 seconds, based on average pedestrian speeds. Also, all drivers would have to stop for this length of time, even if only one pedestrian desired to cross.

In terms of vehicular delay, a pedestrian crossover is far more efficient than a pedestrian-actuated signal or pretimed signal because it apportions right-of-way in such a way as to create minimum delay to vehicles and pedestrians.

It should be mentioned that over 80% of all delays to vehicular traffic occur at traffic signal locations.

If it should ever happen that all pedestrian crossovers were replaced with traffic signals, the result would be intolerable driving conditions, excessive delays to drivers, increased costs to truckers and others who depend upon driving for their livelihood, greatly increased delays to pedestrians and an increase in traffic accidents.

(c) *Flexibility*

The pedestrian crossover operates in a flexible manner, utilizing co-operation between pedestrians and drivers to create minimum delay to all. The traffic signal, whether pretimed or pedestrian-actuated, operates in an arbitrary manner and is relatively inflexible.

Traffic signals are timed for the average speed of pedestrians. Therefore, aged pedestrians and disabled persons are likely to be caught in the roadway when the signal has changed.

However, at pedestrian crossover locations, the aged or disabled pedestrians are allowed for by the driver, who must yield the right-of-way to all pedestrians in the crossover.

It has been observed that pedestrians walk faster in the crossover than at other locations. This is another example of the co-operation which is so desirable.

(d) *Public Opinion on Pedestrian Crossovers*

It is not difficult to evaluate pedestrian crossovers from the standpoint of accidents and delays, but it is very difficult to evaluate the reaction and acceptance of pedestrians and motorists to this device without actually questioning them. For this reason a public opinion poll was carried out on major arteries at pedestrian crossovers and at other locations.

Figure 6
Vehicles stopped for pedestrians in the crossover.

To the question, "What is your opinion of pedestrian crossovers?", the following results were obtained from 331 pedestrians interviewed:

Favourable	292 = 88%
Unfavourable	36 = 11%
Other	3 = 1%
	331 = 100%

Of the 292 in favour, 158 were drivers, 134 were non-drivers. Of the 36 not in favour, 26 were drivers, 10 were non-drivers. Some of the comments given by those in favour:

"very good idea, crosswalks are a must"

"find drivers co-operative"

"very good idea, couldn't cross here without it"

"good idea, but drivers do not co-operate"

"find drivers courteous to pedestrians"

"good idea, if only pedestrians would point in time"

Figure 7
Example of warning sign erected at all highway entrances to the Metropolitan area.

"excellent, couldn't be improved"
"fine if pedestrians would be better informed about pointing their way"
"we could use more of them. Good idea"
"if adults were as intelligent as children there would be no difficulty"
"satisfied as pedestrian, more warning as motorist"
"good enough the way they are, but people should signal (point) and be more careful"
"I think pedestrians use them with good sense on the whole."

(The pointing referred to, is the result of the "point your way to safety" campaign. Pedestrians have been requested to signify their intent to cross by holding out their hand and "pointing.")

Some of the comments given by those not in favour:

"pedestrians should be fined for not giving sufficient warning"
"pedestrians won't learn to use them"
"crossovers at or near T.T.S. stops are ridiculous"
"should be removed so pedestrians would have to pay more attention to traffic"
"pedestrians do not give motorists proper warning"
"suggest push-buttons at all crossovers"
"could do with less of them"
"prefer red lights"

Some of the comments given by those who felt crossovers could be improved:

"need more warning for drivers"
"parking too close to crossovers"
"need better lighting"
"we need more downtown"
"more publicity such as another safety drive is in order"
"the law should be enforced for both pedestrians and drivers"
"they should be spaced more evenly and not too close to signals"
"pedestrians could practice pointing much more"
"flashing light"
"if given a little more time they will definitely be worth the effort"

It is interesting to note that of the 331 pedestrians questioned, 328 or 99% felt strongly enough about crossovers to express an opinion.

(e) *Efficiency of Pedestrian Crossover Versus Pedestrian-Actuated Signal*

It should be noted that since over 90% of all pedestrian crossovers are located at intersections, the vehicular traffic on the minor street would also need to be accommodated in the signal operation.

This would in fact, require a semi-actuated signal, to handle both pedestrian and minor street traffic, as opposed to a pedestrian-actuated signal, which would handle only pedestrian traffic.

Delay

It has already been indicated that the pedestrian crossover is a more efficient traffic control device than a pedestrian-actuated or semi-actuated signal in minimizing delay to both pedestrians and motorists.

Safety

Accident records show that the pedestrian accident rate at signals is approximately double that at crossovers. However, in all fairness, it should be noted that turning movements at signals are usually much heavier than at crossovers, and this possibly accounts for the higher accident rate.

Pedestrian Observance

Pedestrian observance is excellent at most crossover locations, but poor at some. It is significant to note that at two pedestrian-actuated signals studied, the number of pedestrians crossing *against* the signal was as high as 16% and 46%, during the rush hour periods.

The reason for the high non-observance at pedestrian signals is probably due to the lengthy wait for a green signal.

Considering the delay, safety and observance at pedestrian crossovers and pedestrian or semi-actuated signals, it may be stated that a pedestrian crossover is the most effective traffic control device for helping pedestrians to cross busy traffic arteries.

(f) *Use of Flashing Amber Light*

It has been the feeling of some that a flashing amber light would be more effective for attracting attention than the overhead light now being used. This was considered originally and was turned down for the following reasons:

There are at present numerous flashing amber lights which are usually used to warn of some particular hazard. If these were used at all pedestrian crossover locations, there would be many hundreds of flashing lights in the Metropolitan area, and all would lose the effectiveness particularly desired.

A flashing light blinds out a message. If used at pedestrian crossover locations, the message on the overhead sign would be useless.

There is the possibility of legal and practical misinterpretation if flashing amber lights are used.

Costs of Pedestrian Crossover and Signals

	—Cost of average installation—
Pedestrian Crossover	—$ 400.00
Pretimed Signal	—$2,500.00
Pedestrian-Actuated Signal	—$3,000.00
Semi-Actuated Signal	—$3,200.00
Overhead Flashing Amber	—$ 300.00

Publicity Campaign

An intensified publicity campaign under the supervision of the Metropolitan Traffic Safety Bureau is in progress, based on the "point your way to safety" program. The press, radio, and television media are being utilized.

The following features of this campaign are significant: Pedestrian safety literature is being mailed to every family; children are being lectured on the use of crossovers; placards advising pedestrians to "point your way to safety" are being posted throughout the area; a special film on how to use crossovers is being prepared, which will be available for television and home and school ratepayer groups.

The publicity campaign, however, will not prove effective without adequate police enforcement. The majority of motorists and pedestrians will observe regulations, but sporadic enforcement is not enough. Enforcement must be continuous to be effective.

In all publicity with respect to crossovers, the emphasis should be placed on the need for caution by both pedestrian and driver. It should be stressed that the pedestrian crossover is a traffic control device for the convenience of the public, and will work effectively as long as pedestrians and drivers observe proper caution and respect for the rights of others.

Necessary Improvements to Increase Effectiveness

1. Continued publicity, with particular reference to proper pedestrian behaviour at crossovers. This is particularly applicable to children.

2. Enforcement by Police Department on a continued basis.

(Continued on page 54)

Freeway Design Elements

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IT HAS BEEN ALMOST TEN YEARS since I appeared on a program here at the University. In that earlier meeting my subject was "Observations on Urban Highway Design," which is certainly in the same area as my subject for today. So, I dug out a copy of my paper of ten years ago and thumbed through it to see how much the picture has changed during a decade, and to indulge in a little self-appraisal. What was my level of thinking in 1950, and how much has it changed since that time?

I found many of my earlier observations still valid, and that is as it should be, for the years seem to run now rather than pass. But the major change was in the size of the picture and the features spotlighted. Yes, among other things I talked about freeways and their design features in the meeting ten years ago. And I talked about control of access and its benefits and long range economies. But I was "selling" at that time, for, as I pointed out then, most of the Southeastern states did not even have legal authority for establishing controlled access facilities, and the principles of access control had not been accepted by many top highway administrators. In fact, some people were openly and strenuously opposing it. In 1950 a short section of freeway was taking shape in Atlanta, and the first preliminary layouts for the Jacksonville Expressway were being prepared. But that was the total in the Southeast.

Here we are in 1960. Hundreds of miles of freeways are completed or under construction in our states. And several thousands of additional miles are in various stages of planning, design, and right-of-way acquisition. All of our states have legislative authority for control of access, and its principles have reached the level of enthusiastic acceptance by highway administrators.

Although financing problems seem to be with us always, we are relatively "well-heeled" now as compared with 1950. For example, in the State of Florida ten years ago the Federal-aid highway apportionments totalled approximately $8-millions annually, which, with state matching funds, represented a yearly Federal-aid program of only $16-millions. And remember, this covered all classes of roads. But today Florida's annual apportionments are in the order of $70-millions, with an annual Federal-aid program of approximately $90-millions, $62-millions of which must be spent on freeways of the Interstate System. Instead of gleaning out a few dollars here and there to finance a token mileage of freeways (as was the case in 1950), we are now "rolling" on the biggest public works program in history. And the term "freeway" is now a household word.

I shall not try to enumerate the reasons for this almost revolutionary change in the highway picture. I am sure that all of you are fully aware of the tremendous increase in numbers of vehicles and vehicle-miles traveled during this decade, and of the recognition of the need for positive action that led to the passage of the 1956 Highway Act, which made our current program possible.

Among the provisions of the '56 Act, Section 108(i) Standards provides:

> "The geometric and construction standards to be adopted for the Interstate System shall be those approved by the Secretary of Commerce in cooperation with the State highway departments. Such standards shall be adequate to accommodate the types and volumes of traffic forecast for the year 1975. The right-of-way width of the Interstate System shall be adequate to permit construction of projects on the Interstate System up to such standards. The Secretary of Commerce shall apply such standards uniformly throughout the States. Such standards shall be adopted by the Secretary of Commerce in cooperation with the State highway departments as soon as practicable after the enactment of this Act."

Accordingly, the American Association of State Highway Officials adopted on July 12, 1956, and the Bureau of Public Roads approved on July 17, 1956, the "Geometric Design Standards for the National System of Interstate and Defense Highways." I should like to read the General Provisions of these Standards.

> "The National System of Interstate and Defense Highways is the most important in the United States. It carries more traffic per mile than any other comparable national system and includes the roads of greatest significance to the economic welfare and defense of the Nation. The highways of this system must be designed in keeping with their importance as the backbone of the Nation's highway systems. To this end they must be designed with control of access to insure their safety, permanence, and utility and with flexibility to provide for possible future expansion. Two-lane highways should be designed so that passing of slower moving vehicles can be accomplished with ease and safety at practically all times. Divided highways should be designed as two separate one-way roads to take advantage of terrain and

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other conditions for safe and relaxed driving, economy, and pleasing appearance. All known features of safety and utility should be incorporated in each design to result in a National System of Interstate and Defense Highways which will be a credit to the Nation.

"These objectives can be realized by conscious attention in design to their attainment. All Interstate highways shall meet the following minimum standards. Higher values which represent desirable minimum values, a device used in previous Interstate standards, are not shown because it is expected that designs will generally be made to values as high as are commensurate with conditions, and values near the minimums herein will be used in design only where the use of higher values will result in excessive cost. In determination of all geometric features, including right-of-way, a generous factor of safety should be employed and unquestioned adequacy should be the criterion. All design features required to accommodate the traffic of the year 1975 shall be provided in the initial design; however, where justifiable, the construction may be accomplished in stages.

"The American Association of State Highway Officials' Policy on Geometric Design of Rural Highways, the Policy on Arterial Highways in Urban Areas, when adopted, and the Standard Specifications for Highway Bridges shall be used as design guides where they do not conflict with these standards."

The Standards then go on to set out the minimum Interstate requirements under the headings of Traffic Basis; Control of Access; Railroad Crossings; Intersections; Design Speed; Curvature, Superelevation, and Sight Distance; Gradients; Width and Number of Lanes; Medians; Shoulders; Slopes; Right-of-Way; Culverts; and Bridges and Other Structures.

So, with the passage of the 1956 Act and with the adoption of the Standards which have the backing of the law, we have our basis for proceeding with the design of the freeways that make up the Interstate System.

Since the passage of the 1956 Highway Act, the pressure has been tremendous. We had to get the show on the road. In doing so all of us, I am sure, have proceeded along lines that always seemed to be sound, but we would probably have proceeded along other and even better lines had we then had the experience we now have. I do not intend to cite specific examples wherein our judgment may have been somewhat questionable. I believe they would represent only a minor percentage of the total work accomplished thus far. But regardless of the pace we are setting and the pressures under which we are working, taking inventory, as in any business endeavor, is a necessary and beneficial action. We must know what we have done, where we stand, and then determine where we are going. All of us are learning new lessons every day and we will continue to learn throughout the Interstate program. The important question is—Are we making, and will we continue to make, the maximum use of our increased knowledge?

I believe in my own mind that we should take our longest and most critical look at what we have done and are doing in and to our urban areas on the Interstate System. What degree of motorist service should we provide at and within the cities to be connected by the Interstate System highways? In which cities do conditions warrant development of an Interstate highway on a location through the heart of town, which ones should be served by a location through the outlying developed areas, and which cities should be bypassed? Certainly the population of the urban area and the ratio of total capital outlay to the total population, or the per capita investment, *could* serve as one yardstick.

In selecting our locations we should make full use of economic analyses. This is big business, so let's handle it accordingly. In developing benefit-cost ratios for several alternate locations it is axiomatic that the greater the total of vehicle-miles of travel assigned to a particular location the better are its chances of showing a high benefit-cost ratio. At this point I make a plea to all of us to take another look at our traffic assignment approach. I feel that in some instances we have wandered out into left field, and have assigned traffic to the Interstate which has no business being there. The Interstate System will fulfill many highway transportation needs but cannot cure all of the traffic ills of an urban area. There must be other facilities planned and constructed to constitute an integrated plan for the city. And traffic assignments must be made on the assumption that these *other* facilities will be carrying their full and rightful share of the traffic load. An allied error lies in the assignment of short, purely local, trips to the Interstate facility. This mistake is pure dynamite in its detrimental effects, for it leads to the conclusion by some planners and some engineers (I have encountered both) that interchanges on the Interstate highways should be located at very short intervals in order to pick up and discharge these short-haul vehicles that actually should be accommodated on some other facility.

What are the results of this overassignment of traffic? The freeway facility grows like a weed, with extra traffic lanes, additional interchanges, more right-of-way, and additional expenditures of dollars. These may be dollars that we do not have. The Interstate "pot" is not unlimited, and we must be able to justify all projects financed from it.

In addition to the added costs, and perhaps overshadowing them, are the disastrous effects on operational values. The very integrity of the freeway is impaired by strictly local movements, with resulting weaves and merges, between closely spaced interchanges. We find ourselves in the unenviable position of paying a high price for a high quality product that might not render satisfactory service in actual operation.

One would conclude that I am placing the entire responsibility for this area of judgment on the people who are charged with making traffic assignments. Permit me to place equal responsibility on the designers and officials who have not been able to get away from the concept of local service in planning a traffic facility, regardless of its major purpose. In our urban areas we must have high-type facilities that render this local service. But these must be *in addition to* the Interstate System. To attempt to impose this added burden on the Interstate is to violate its very concept and could lead to the destruction of the total program.

So, let's assume that we are to obtain near-perfect traffic assignments, that interchanges are to be spaced intelligently at optimum intervals, and that our economic analyses are 100% objective. We will no doubt find that

some of our Interstate locations, as first conceived, will be subject to considerable adjustment. Perhaps these adjustments will be of a minor nature in the larger urban areas. But in the smaller cities we may very well find that the justifiable location will shift to the outer fringes or beyond and become by-passes.

Perhaps I have not given you any firm answers thus far. Some of you may wish to take issue with me. In any event, I hope that I have provoked some thought that may lead to ultimate benefits.

In the development of a freeway the first determinations to be made are, which intersecting facilities are to be terminated or rerouted, which are to have grade separations without ramps, and which are to be provided with interchanges. Conclusions regarding these are a part of overall planning, location, and design.

At a meeting in Atlanta some four years ago, the design engineer for one of the leading highway departments said that if he could send his top designers into the field to establish the location and preliminary layouts for interchanges, and then have the locators connect up the successive interchanges, he believed he would obtain better freeways. Perhaps this gentleman was indulging in a bit of exaggeration, but he succeeded in making the point that interchanges are of primary importance and must receive careful attention in establishing a freeway location.

At the other end of the scale is the engineer who establishes a fine location for the through roadways and then "tacks on" an incongruous arrangement of ramps hardly worthy of the name "interchange," but which nevertheless affords the only means by which traffic can enter or leave the freeway. This approach has no place in our Interstate System program.

Now, let's move on to some of the specific features of freeway design. I shall hit some of the high spots based on accepted design principles, and in addition offer some of the observations made by the Special Freeway Study and Analysis Committee of the American Association of State Highway Officials. This Committee observed operations on hundreds of miles of freeways across the country during the last four months of 1959. Their report has now been published by AASHO as an informational guide.

The Committee found that, where major design items were of a high order, geometric elements were properly designed, and adequate operational controls were exercised, smooth traffic flow was being obtained even on facilities carrying volumes up to rates of 2,000 vehicles per lane per hour, and with low accident experience compared to facilities built to lower standards. Where traffic difficulties were experienced, it generally was due to disruption of smooth flow by such items as improperly designed ramp terminals, short weaving sections, too close spacing of entrances and exits, abrupt decrease in number of lanes, and ineffective marking and signing. These were manifested by driver hesitation and other erratic driver behaviors in merging with and emerging from the through traffic streams when operating at high volumes, and by the resulting traffic concentrations.

The desirability of above-minimum designs, where disproportionate costs are not involved, is obvious. This applies both to facilities on which capacity volumes are expected and those with anticipated low volume high-speed conditions under which the rate of the more severe types of accidents generally is higher.

Interchanges

The location of interchanges and the selection of interchange type are of the utmost importance. The spacing of interchanges is a determination of design to fit traffic needs.

In rural areas interchanges will be a few miles apart or many miles apart depending upon the traffic demands, the network of other roads, and compelling public needs. In all cases, justification is a "must."

In urban areas we must give weight to additional considerations in order to assure proper circulation of traffic on the arterial and local streets of the city affected by traffic turning to and from the freeway. To do otherwise may concentrate interchange traffic at one or a few locations in such volumes that serious disruption of traffic on both the local streets and the freeway can result.

Distribution among several streets rather than concentration on one or two would seem to be preferable, provided:

(1) space is available and conditions are amenable for proper design of the interchange turning roadways.

(2) sufficient length is available along the freeway for proper entrances and exits.

(3) sufficient length is available for installing signing and marking for smooth and proper traffic operation, and

(4) sufficient length is available for effecting needed transition between freeway and street operation, and accommodating traffic destined for or coming from the freeway on adequate local facilities.

Let me emphasize the use of the word "length" in the enumerated provisos. Lack of attention to this element will lead to too-frequent interchanges, which in turn would encourage freeway use by short-distance traffic which can block normal freeway travel by overloading certain sections or increasing entrance and exit movements.

The type of interchange selected for any specific location will vary from the simple diamond to the fully directional interchange. Diamonds are particularly appropriate in rural areas and for locations in urban areas where the cross streets are adequate for the combined through and turning traffic, and the facilities for storage, as on ramps or frontage roads, are adequate, and the traffic control fits the needs of traffic. In urban areas many diamond type interchanges have been operating efficiently with high volumes of turning traffic. The intersection of the ramp and the cross street can be signalized just as any other intersection along the surface facility, provided reasonable spacing can be obtained.

Where additional capacity must be developed at the intersection of a ramp and a cross street, it may be accomplished by (1) additional lanes on the cross street or the ramp or both, (2) separate right or left turn lanes, (3) other channelization, and (4) specially designed traffic signal control and sequencing.

Particularly adaptable in urban areas is the split diamond design. In this arrangement each pair of ramps is connected with one of two parallel and usually adjacent streets. Additional advantage is gained from the operation of the two streets as a one-way pair.

Diamond interchanges have many advantages. They require a relatively narrow band of right-of-way; traffic can enter and leave the freeway at relatively high speed; left-turning ma-

neuvers entail little extra travel distance; signing is no problem; and operation is easy, since no sense of confusion is created in the driver's mind.

The two-quadrant interchange, involving a partial cloverleaf, has application in some cases where site conditions warrant. However, this type has the same limitations as a diamond insofar as left turns at the crossroad are concerned, and is generally inferior to the diamond from the standpoint of operation and the effect on the separation structure.

The cloverleaf is the only 4-leg, single structure pattern without terminal left turns at grade. It has application primarily in suburban and rural areas at major crossroads where left turns at grade cannot be accomplished easily and safely. The crossroad should always be a divided highway through the interchange area. The cloverleaf is costly in right-of-way, construction, and in travel distances required for left turning traffic. The weaving maneuvers and limited traffic capacity of the area between adjacent loops are distinct problems, sometimes requiring the addition of collector-distributor roads. The cloverleaf is difficult to sign, particularly one without collector-distributor roads, and is more confusing to drivers than is the diamond.

Interchanges at intersections of two freeways nearly always involve some directional or semidirectional ramps. The conventional cloverleaf is rarely adaptable, except possibly those with collector-distributor roads. Interchanges between two freeways require individual design to fit the volume and pattern of turning movements. The layout preferably should be devoid of weaving. Auxiliary connections to the local road or street system generally should be omitted to avoid too complex a layout. They should be well removed from the major interchange, but where this is not feasible, and certain local connections are essential, collector-distributor roads may be used to advantage to reduce conflicts and weaving movements on the through roadways.

In the design of an interchange, full traffic information and complete data on physical features of the site must be available and must be fully utilized. As the complexity of the interchange increases, so will the number of alternate layouts that should be prepared and considered. Each design should be tested for capacity and operation, adjusted, and tested again. This procedure may sound laborious and time-consuming, but it is essential to good design. However, short-cuts should be used through preparation of single-line sketches. By this method many obviously unsatisfactory schemes can be eliminated from consideration without preparing more detailed layouts.

Uniformity of pattern and its effect on operation of interchanges along a route should be considered, particularly in urban areas. A dissimilar arrangement of exits between successive interchanges, such as an irregular sequence of right and left off-movements, causes confusion, slowing down on high-speed lanes, and forced weaving. However, in the case of an occasional interchange with another expressway or freeway, where some of the turning movements assume the nature of through movements, uniformity with other changes on the route is not as important as providing natural, directional and adequate paths with a minimum of decisions to be made by the driver.

Each section of freeway that includes a series of interchanges or a succession of exits and entrances should be tested for operational characteristics of the route after the preliminary design for each interchange is completed. The test is an evaluation of the section for ease of operation and for route continuity from a driver's point of view. A route may be tested by isolating that part of the plan for each path and examining it only with regard to other parts of the layout which will affect a driver on the path being tested. Viewing an entire plan, as it might be seen from the air, may give an impression of complexity because of the number of exits, entrances, and ramps and structures, which actually is not complex to a driver who sees only the path he is driving. On the other hand, certain weaknesses of operation may not be evident on an overall plan but will be revealed in testing a single travel path.

Such an analysis indicates whether or not there is likely to be confusion because of exits and entrances too close together or interference because of successive weaving sections. It should show also whether or not the path is clearly defined, if it is feasible to sign the facility properly, and if major or overhead signs are required and where they may be placed. The test might show that the path is easy to travel, direct in character, and free from sections that might confuse drivers. Or, it may show that the path is sufficiently complex and confronted with disturbing elements so as to require adjustment or radical change in design.

Ramps

The principal interference with the smooth flow of traffic on a freeway is the entering and leaving traffic and the manner of its merging and emerging. However, smooth flow is not disrupted where the design of turning roadways and exit and entrance terminals is fully adequate, and where spacing between ramp terminals is sufficient to enable drivers to adjust their driving to the conditions. Interference is caused chiefly by abrupt, inadequate entrance ramp design, ramps too close together, and hesitation on the part of entering drivers.

An important consideration in *entrance* ramp terminal design is visibility: Ability by through drivers to see entering traffic and ability by entering drivers to see the merging situation and the opportunities for entering the through traffic lanes.

Where visibility is poor, entering drivers frequently slow down or stop and are generally unable to use the available short gaps in the through traffic. Accidents, particularly the rear-end type, occur on the ramp when an entering driver makes a false start and then applies his brakes when more through traffic in the outer lane comes into view.

Entrance ramps at the merging nose ordinarily should be one lane wide, with sufficient shoulder width to enable the passing of a stalled vehicle. Where the volume of entering traffic exceeds the capacity of one lane, the design required is that for a major junction.

The AASHO Committee recommends that the merging nose be offset from the edge of the through lanes, preferably by the width of shoulder, and that the area between the through lanes and the entrance ramp beyond the nose be a flush surface unobstructed by barriers or curbs.

Entrance ramp terminals should be designed so that entrance and merging can be accomplished at high speed, with a flat entrance angle of about 50:1. A flush shoulder should flank the merging area and join with the normal shoulder adjacent to the through lanes. There should be no curbs of any kind where the merging area ends on the shoulder.

No signs are necessary except in

those cases where tight conditions limit visibility. Pavement marking should consist of the lane lines of the through pavement, a solid line adjacent to the ramp lane extending a short distance beyond the nose, and a dashed line extending from the solid line (1) for half the length of the full width lane in the case of a parallel acceleration lane, or (2) for a length not extending beyond the point where a tapered acceleration lane becomes 11 feet wide.

Exit ramp terminals should be designed so that (1) there is a clear cue to the driver that this is a point of departure from the through lanes, and (2) the act of leaving the through lanes can be accomplished without slowing down, the deceleration being accomplished on the turning roadway or on a parallel deceleration lane after leaving the through traffic lanes.

The clear cue is provided by a definite change, such as a definite angular departure rather than a very gradual curve which might entice the through driver into the ramp. A high-speed exit is best provided by a flat angle of 4 or 5 degrees. A parallel additional lane combined with a flat angle exit may be desirable under heavy volume conditions. This will provide a clearer view of the ramp and signs, and will provide space clear of the through lanes for those drivers who decelerate in advance of the ramp takeoff point. This should not be the only means for decelerating, however, for many drivers will turn at high speed directly into the turning roadway.

The exit nose should be offset from the edge of the through lanes some 10 to 12 feet to enable an occasional vehicle, which has inadvertently left the through lanes, to return to them without disrupting through traffic. The pavement, or the full-width paved shoulder, should extend some distance beyond the nose, and in no case should any curbs encroach on the shoulder in this area, in order that the recovery maneuver can be accomplished without difficulty or hazard. The nose should also be offset 3 or 4 feet from the normal ramp lane.

A flat angle of 4 or 5 degrees combined with the nose offsets will provide a sufficiently long and wide neutral area in advance of the nose. This area should be well defined by pavement marking, but there are conflicting opinions as to the necessity for contrasting pavement or surface roughening in this neutral area.

Except for major fork treatments, exit ramps should provide for one lane movement, with storage, if needed on the ramp, provided by widening the ramp beyond the nose.

There must be sufficient length of ramp between the nose and the crossroad to accommodate the required speed change. And, where an exit ramp joins an adjacent roadway before reaching the crossroad, and traffic is not well below capacity, there should be sufficient length and width between the junction and the crossroad to accommodate weaving movements and storage.

Sight distance is always important. Ramp profiles should be designed in combination with the horizontal alignment so that sight distance will not be restricted. For example, at an exit terminal to a descending grade a horizontal curve ahead should not appear suddenly to a driver using the ramp. Also, any delay or stack-up on the ramp should be visible to following drivers well in advance.

Cross Section Elements

Lanes 12 feet wide are accepted as standard for the through traffic lanes of a freeway. Although some facilities have been constructed with certain lanes slightly wider, there is not sufficient evidence of the need for more than the 12-foot width.

Shoulders on the right should have 10 feet of usable width, preferably paved, flush with the through pavement. Any curbs needed for drainage should be placed at the outer edge of the shoulder, in order that traffic making emergency stops can move off the traffic lanes at high speed.

Use of the paved shoulder as a through traffic lane should be discouraged by through traffic lane edge striping, use of contrasting color and texture, and in special cases by diagonal marking or roughening of the shoulder.

Paved shoulders should also be provided on the left. For 4- and 6-lane facilities, the paved width should be 3 or 4 feet, while on an 8-lane section up to 10 feet of usable width is in order. The left shoulders also should be flush with the through pavement.

I believe that everyone is aware of the desirability of wide medians, which reduce headlight glare, are more pleasing to drive, and offer a "landing spot" in an emergency. But liberal widths are not always obtainable at a reasonable cost. The important thing is that medians be designed. In areas of relatively inexpensive right-of-way, the median width should be varied and each roadway designed separately both in alignment and profile. In areas of costly right-of-way, narrower dimensions are necessary, but maximum attention should be given at the design stage to the optimum use of the right-of-way, in relation to partial or total takings of successive parcels, to accommodate the several elements that make up the total cross section dimension.

Signing, Marking, and Delineation

There is one element of freeway design that, in past years, did not receive proper attention. I am speaking of signing. The signing of a freeway is an appropriate part of design, and can very well control the design. Clarity of paths to be followed, safety, and efficiency depend largely on proper signing. With today's increased traffic volumes, higher vehicular speeds, and sometimes complex interchanges, the problem of helping the motorist find his way is becoming more and more difficult. Fortunately we now have the AASHO Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways. The intelligent application of the provisions of the Manual and its revisions and interpretations is producing designed signing and marking, and will provide throughout the country the uniformity that has been needed for such a long time.

In the past few years tremendous progress has been made not only in the construction of miles of freeway, but also in the planning and design techniques. We have had the opportunity to observe the good and bad features of facilities under varying operating conditions. We are designing and building freeways that incorporate the best of what we have learned thus far. Research is being done, and more will be carried out in the future. Steady progress and constant improvement are evident everywhere.

Through the combined efforts and cooperation of capable administrators, highway engineers, traffic engineers, planners, researchers, and an informed and understanding public, the traffic facilities that are so vital to the safety of our people and the economy of our Nation will be built, and they will be built in true American style—the very best.

Traffic Distribution Forecasts — Highway and Transit

By Henry D. Quinby
Principal Transportation Engineer
Parsons, Brinckerhoff, Quade and Douglas
Engineers — New York - San Francisco

THERE IS growing evidence of the need for more thorough and definitive methods to predict the distribution of total person-trips within a metropolitan area as between highway and transit networks. As metropolitan areas grow in importance in the American economy and their transportation problems become more complex, it becomes necessary to estimate with greater analytical resource the effects which various types and extents of public transit facilities might have on transportation planning and traffic volumes in such areas. One of the areas where the need for such research has recently been strong is the San Francisco Bay Area.

In 1957 the California State Legislature created the San Francisco Bay Area Rapid Transit District. The Legislature charged it with the task of developing and putting into operation a system of interurban regional rapid transit for the five central counties of the Bay Area. The formation of this District was the logical outcome of the work of its predecessor body, the San Francisco Bay Area Rapid Transit Commission, which conducted extensive engineering and other fact-finding studies in 1952-1956. The engineering report, entitled "Regional Rapid Transit" and submitted to that commission in 1956 by Parsons, Brinckerhoff, Hall and Macdonald, formed in large part the basis for the scope and mission of the rapid transit facilities currently being studied by the District's engineering consultants, Parsons Brinckerhoff-Tudor-Bechtel.

The five-county regional rapid transit system under study at the present time includes as its principal link a two-track, subaqueous Transbay Tube between downtown San Francisco and Oakland. From this basic link, interurban rapid transit lines would extend to Richmond, Concord, and Fremont on the east side of the Bay, down the Peninsula to Redwood City and Mountain View, and to Ignacio in Marin County. The initial system recommended by the engineering consultants is shown in solid lines in Figure 1. It falls within the estimated borrowing capacity limits of the District and contains 98 double-track route-miles costing $922,000,000 at current price levels. When the Transbay Tube link is excluded from this estimate, since it would be financed by tolls from the Bay Bridge, the recommended system would cost $794,000,000 at 1960 levels.

Important in these studies, preliminary reports of which were submitted to the Transit District in May and June of 1960, is the prediction of the volumes of passenger traffic which will be attracted to its several routes. These patronage estimates are important not only to the justification for and financing of the system but also to its extent, functional design, detailed plan of scheduled service and day-to-day operation, and the expense estimate for such operation. Until fairly recently, techniques for predicting the distribution of metropolitan traffic between highway and transit facilities have suffered from a lack of both systematically organized field data and the type of correlation analysis which must be performed on such data to develop scientific and effective forecast techniques. Oftentimes, reliance has of necessity been placed on hypothetical transit diversion curves based largely on earlier research studies to predict the distribution of vehicular traffic between old and new highways.

In 1956 and 1957, however, an investigation of these modal distribution forecast techniques was made by the Cook County Highway Department in its "Chicago Transportation Usage Study." Instead of relying on a single diversion curve applied to most or all types of trip, as has often been the practice in the past, the Chicago study divided the total trips under study into such categories as: oriented or non-oriented to the Chicago central business district; work or non-work in purpose; auto-essential or transit-essential, as well as the large pool of discretionary trips not irrevocably oriented to either the automobile or transit. In the Chicago study, also, cost-ratio as well as time-ratio were studied as measures to produce diversion curve graphs. This research was valuable in producing a new transit diversion curve to be specially applied to work trips to the C.B.D. and outlying areas, where choice existed between transit and auto transportation (Curve 2 in Figure 2). A second curve was developed for application with work trips to the C.B.D. only, where a similar choice in mode existed (Curve 3 in Figure 2). This research was based on a limited number of field trip samples. A broader base of observed data and added study of mode-influencing factors could confirm and further strengthen the foundation of this valuable research for application in other metropolitan areas.

Basis for Bay Area Study

An investigation of rapid transit traffic diversion was undertaken in 1954 and 1955 for the estimates incorporated in the engineering report to the former San Francisco Bay Area Rapid Transit Commission. The more elaborate diversion research studies completed in the current District engineering program and described in this paper are in part based on this earlier work. The basic field data consists of the roadside and mass transit origin-destination surveys conducted in the spring of 1954 throughout the Bay Area for the rapid transit project. Also available from these surveys were factual data on Bay Area transit and auto travel times, costs, and distances, as

This paper received an honorable mention in competition for the 1960 Past President's Award of the Institute of Traffic Engineers.

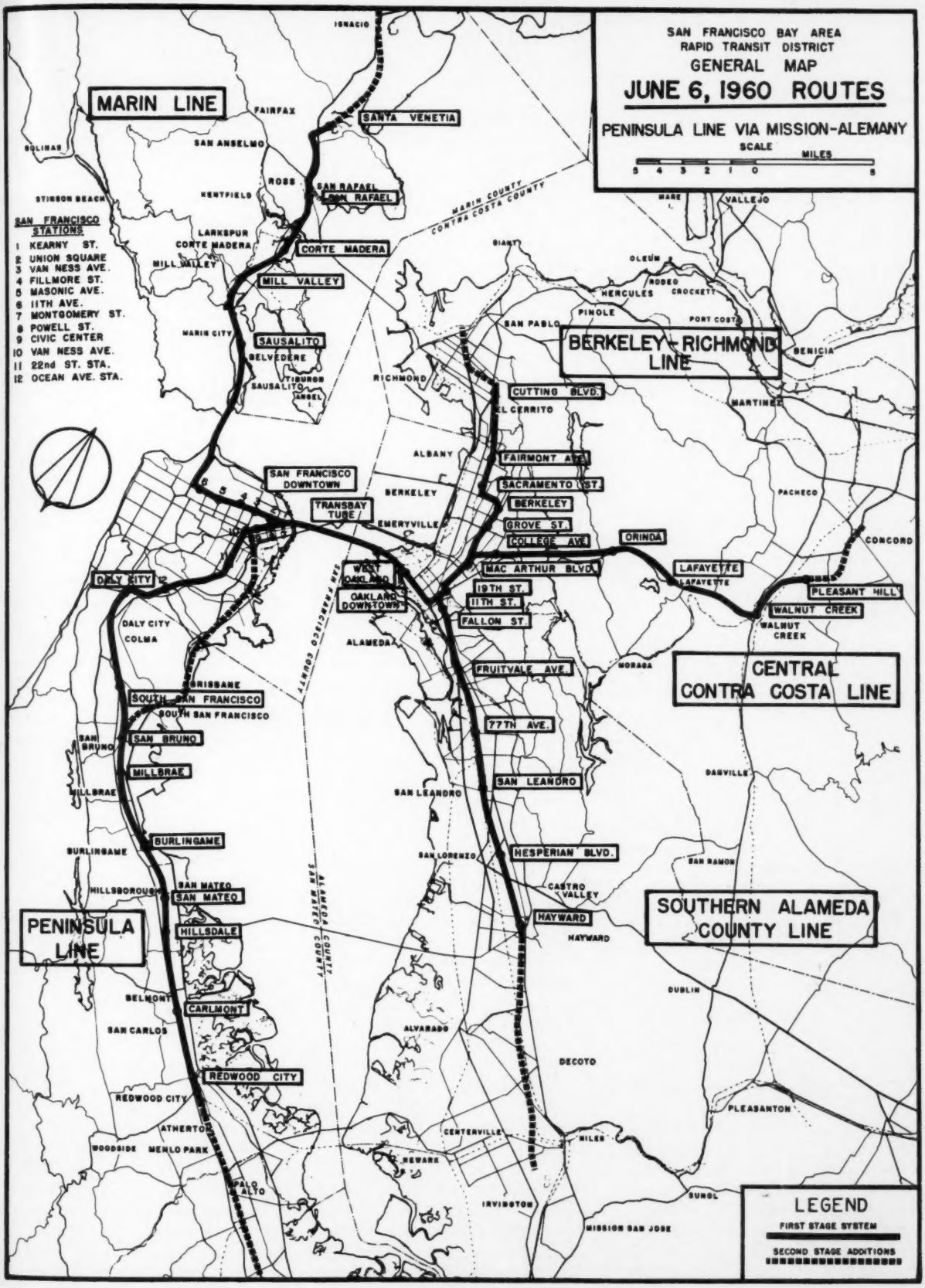
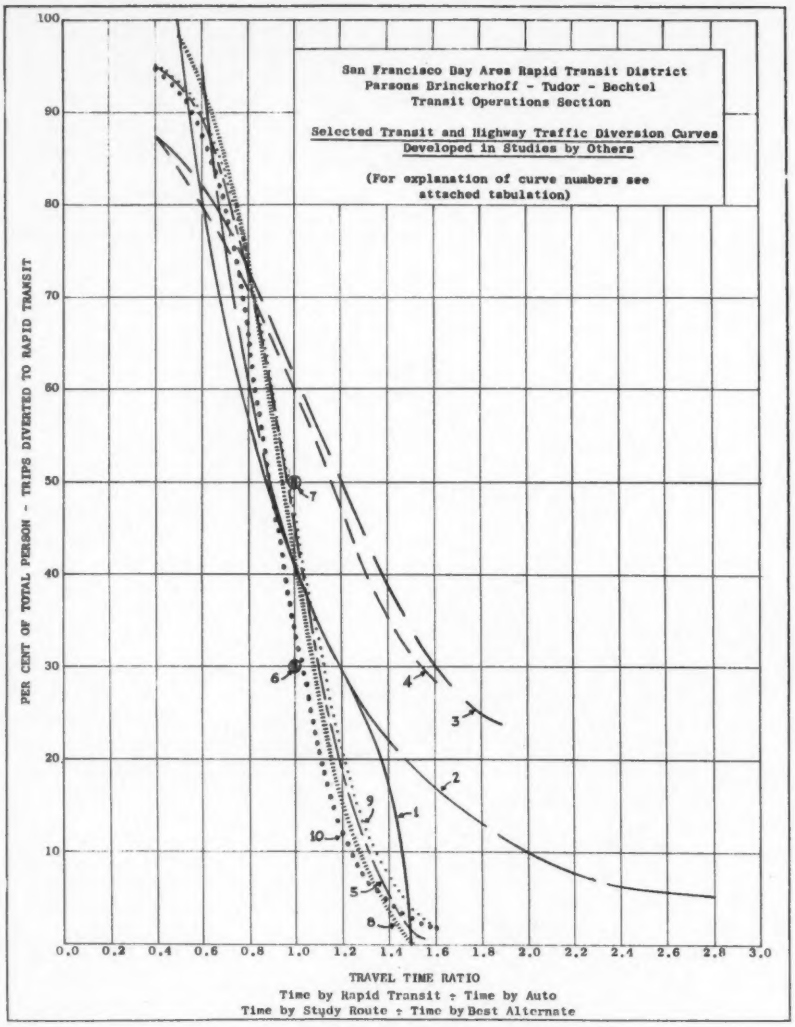

SAN FRANCISCO BAY AREA
RAPID TRANSIT DISTRICT
GENERAL MAP
JUNE 6, 1960 ROUTES
PENINSULA LINE VIA MISSION-ALEMANY
SCALE
MILES
5 4 3 2 1 0 5
MARIN LINE
BERKELEY - RICHMOND LINE
CENTRAL CONTRA COSTA LINE
SOUTHERN ALAMEDA COUNTY LINE
PENINSULA LINE
SAN FRANCISCO STATIONS
1 KEARNY ST.
2 UNION SQUARE
3 VAN NESS AVE.
4 FILLMORE ST.
5 MASONIC AVE.
6 11TH AVE.
7 MONTGOMERY ST.
8 POWELL ST.
9 CIVIC CENTER
10 VAN NESS AVE.
11 22nd ST. STA.
12 OCEAN AVE. STA.
SAN FRANCISCO DOWNTOWN
TRANSBAY TUBE
OAKLAND DOWNTOWN
WEST OAKLAND
SAN FRANCISCO COUNTY
ALAMEDA COUNTY
MARIN COUNTY
CONTRA COSTA COUNTY
SANTA VENETIA
SAN RAFAEL
CORTE MADERA
MILL VALLEY
SAUSALITO
CUTTING BLVD.
FAIRMONT AVE.
SACRAMENTO ST.
BERKELEY
GROVE ST.
COLLEGE AVE.
ORINDA
MAC ARTHUR BLVD.
LAFAYETTE
PLEASANT HILL
WALNUT CREEK
19TH ST.
11TH ST.
FALLON ST.
FRUITVALE AVE.
77TH AVE.
SAN LEANDRO
HESPERIAN BLVD.
HAYWARD
DALY CITY
SOUTH SAN FRANCISCO
SAN BRUNO
MILLBRAE
BURLINGAME
SAN MATEO
HILLSDALE
BELMONT
CARLMONT
SAN CARLOS
REDWOOD CITY
ATHERTON
MENLO PARK
PALO ALTO
LEGEND
FIRST STAGE SYSTEM
SECOND STAGE ADDITIONS

Figure 1


San Francisco Bay Area Rapid Transit District
Parsons Brinckerhoff - Tudor - Bechtel
Transit Operations Section
Selected Transit and Highway Traffic Diversion Curves
Developed in Studies by Others
(For explanation of curve numbers see attached tabulation)
PER CENT OF TOTAL PERSON - TRIPS DIVERTED TO RAPID TRANSIT
100
90
80
70
60
50
40
30
20
10
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0
TRAVEL TIME RATIO
Time by Rapid Transit ÷ Time by Auto
Time by Study Route ÷ Time by Best Alternate

EXPLANATION OF CURVE NUMBERS
For Graph of Selected Transit and Highway Traffic Diversion Curves Developed in Studies by Others

Curve No.	Line Symbol	Curve Developed By	Year	To Be Used With
		RAPID TRANSIT		
1	————	Washington, D. C. Mass Transportation Survey	1953	Non-Oriented Trips of all Types Potentially Divertible to R. T.
2	— —	Chicago Transportation Usage Study	1957	Non-Oriented Work Trips to & from C.B.D. & Outlying Areas
3	— — —	Chicago Transportation Usage Study	1957	Non-Oriented Work Trips to & from C.B.D. Only
4	— — — —	San Francisco Transportation Technical Committee	1959	All Trips of Interest to Local San Francisco R.T. to C.B.D. (All Orientations, All Times of Day, All Purposes)
5	— ——— —	Southern New Jersey Rapid Transit Study	1959	All Trips of Interest to Southern New Jersey R.T.
6	(R)	Metropolitan Toronto Planning Board & Toronto Transit Commission	1958	Peak Period Transit Trips of all Types Divertible to Local R. T.*
7	(N)	Metropolitan Toronto Planning Board & Toronto Transit Commission	1958	Offpeak Period Transit Trips of all Types Divertible to Local R. T.*
		HIGHWAY		
8	.....	U. S. Bureau of Public Roads	1956	All Vehicular Trips of Interest to "Interstate" Freeway System
9	.....	American Assn. of State Highway Officials	1957	All Vehicular Trips of Interest to Urban Freeways
10	o o o o o	American Assn. of State Highway Officials	1957	All Vehicular Trips of Interest to Urban Major Streets

* The two Toronto curves (6 & 7) are time-differential (time-saved) curves, rather than time-ratio. Therefore, the only plottable points are at 1.0 time-ratio (zero time-differential).

Figure 2

well as records of automobile ownership, personal income levels, and other trip-influencing factors.

Within the nine counties of the Bay Area which were covered in the 1954 O-D surveys, there exists a section or corridor of particular significance as a laboratory for diversion percentage research. This corridor lies between San Francisco and San Jose on the Peninsula and is hemmed in by the Bay to the East and by the spine of hills down the center of the Peninsula to the West. It is shown on the Bay Area map (Figure 1). Within this heavy-volume interurban traffic corridor there existed in 1954 reasonably good highway facilities, including the Bayshore Freeway, and, by traditional concepts, reasonably good interurban transit service provided by the Southern Pacific commute trains and complemented by an extensive network of Greyhound bus routes. The quality of service offered by these interurban transit facilities was the closest approach in the Bay Area to the service which would be offered by the proposed regional rapid transit system. The Peninsula corridor laboratory, with its high trip volumes, hemmed-in area, and reasonably balanced highway and transit facilities, offered a unique and valuable basis for study of the various factors which influence the distribution of regional interurban travel between highway and transit. All told, from the field interview surveys, some 14,797 automobile and transit interviews were obtained for trips through the Peninsula corridor and of interest in this research. When expanded to 100 per cent of the volume involved, these interviews represented approximately 200,000 weekday interurban highway and transit trips through the Peninsula corridor.

Mode-Influencing Factors

A great variety of factors directly or indirectly influence the allocation of person-trips between highway and transit within metropolitan regions. A number of these factors are relatively intangible and/or have never been systematically collected as field data. Nevertheless, the factors which appear from study most crucially to affect diversion are normally measured in field transportation surveys and were available for this research. It was possible to divide the trip data by work, shop, home, and other purpose; by peak and off-peak periods; by mode and direc-

tion of travel; by O-D pattern, and particularly by whether trips have either or both terminals in a major downtown area. Bay Area auto and transit travel time, cost, and distance data were available for each zone-to-zone movement under study. Data on auto-registration, personal income, and other mode-influencing factors were also available for groups of zones in the study area. It was, therefore, possible not only to divide the trips of interest into the separate categories mentioned above, but also to test each category by such various methods of measurement as time-ratio, time-differential, cost-ratio, cost-differential, time-cost-ratio, distance-ratio, and distance-differential.

Preliminary Diversion Graphs

Despite the large interurban traffic volumes of interest in the Peninsula corridor, a number of the trip categories just enumerated contained too few trips to be statistically stable for research. After their exclusion, 113 preliminary diversion graphs were prepared with valid trip volumes. The vertical axes of these graphs are labeled "Per Cent of Total Person-Trips Using Public Transit" and the horizontal axes are calibrated to the particular ratio or differential measurement being applied. It was determined to be statistically valid first to group the data for each graph by ratio or differential increments, rather than initially to plot the scatter of points representing each zone-to-zone movement involved. The plotted grouped data points on each graph were connected by straight lines to form a rough "curve" which was then initially reviewed to determine the general degree of validity, usefulness, and correlation thereby suggested. This review of the preliminary diversion graphs showed that a large number of the combinations of trip categories and ratio or differential measurements could not yield valid and useful results for modal traffic distribution forecasts because of the shape, slope, range, and position of the plotted curves.

A rating system was devised selectively to eliminate those graphs of no apparent further value in the study. It was not surprising, for example, to find that trips with shopping as their purpose constituted a very small percentage of the total trips under study; the graphs involving such trips often reflected irregularities arising from the small volumes of available data. Relatively few long-length interurban metropolitan trips appeared to have shopping as their primary objective, especially since the average length was around 16 miles for the trips under study in the Peninsula corridor.

Such measurement bases as cost-differential, distance-differential, distance-ratio, time-differential, and degree of auto ownership, offered curves of very limited or negligible validity, usefulness, and correlation by visual inspection. Measurement of trip data by cost-ratio offered somewhat improved but still relatively invalid and unusable results, principally because transit fares and trip costs often were in the same general range as comparable trip costs by automobile. Measurement by personal income levels produced a relatively acceptable curve, but it was readily recognized that it would be most difficult to predict future relative income relationships for the various sections of the Bay Area, as well as to adjust the derived curve for estimated future effects of inflation. In some cases measurement by time-cost-ratio yielded curves of quite reasonable shape, slope, range, and position, often equaling or approaching the quality of curves obtained by time-ratio. However, the curves which offered generally the most reasonable results were those obtained through measurement by time-ratio. In the 1957 Chicago Transportation Usage Study, previously referred to, time-ratio and cost-ratio were the only ratio-differential measurements reported on, and cost-ratio, as shown in Graph Nos. 4 and 5 of that report, did not yield a range or position on the diversion graph, which would suggest strong applicability in the Bay Area modal traffic distribution forecasts. Measurement by time-cost-ratio, if it is to be used in estimating rapid transit traffic, involves measurement of travel cost as well as travel time between each pair of traffic zones, and hence considerably greater data collection and computation than does the simpler measurement of time-ratio. In view of the above evidence from the preliminary graphs, further study and analysis were restricted to the graphs involving time-ratio.

The use of time-ratio as the measurement basis in this study is predicated on the assumption that transit and auto travel costs will be approximately equal for most movements of interest. Were this not to be the case, the cost factor would have to be incorporated in the diversion curves to be used, since significant differences in travel cost obviously have an important influence on modal traffic distributions. The fare structure for the rapid transit system has been set so that, for the great majority of movements of interest, travel by this mode will cost approximately as much as the out-of-pocket per-person cost of the same movement by automobile. Had cost-ratio or cost-differential been used as the basis of measurement, a majority of the trips of interest would therefore have had a cost-ratio approaching 1.0 or a differential approaching zero. Time-ratios, on the other hand, cover a relatively wide range of values and thus offer a more stable basis for predicting modal traffic distributions.

Time, cost, and distance calculations in this study included the effect of all portions of each trip between initial origin and ultimate destination for both auto and transit travel. Thus, for trips made by transit, the element of travel to and from the stations or stops was considered along with travel on the transit system itself.

Semi-Final Diversion Graphs

From the preliminary group of 113 graphs, 19 involving time-ratio and, in the aggregate, covering all trips of interest in the Peninsula corridor, were selected as semi-final graphs for further refinement. It will be remembered that the semi-final graphs showed a series of grouped data points linked by straight lines, the points representing trip data grouped about small increments of time-ratio. The resulting "curve," merely a series of straight lines connecting the data points, indicated the general shape, slope, range, and position of the traffic diversion curve developed for the particular trip category shown on that graph. At this stage it was necessary to formalize or refine the rough curve into a smooth, trended curve extending over the effective time-ratio range from approximately 0.0 to upwards of 3.0. In some studies the smoothing or formalization of the diversion curves yielded by the graphic data is accomplished by fitting by eye. More commonly, however, regression equations are employed to formalize the final curves. In the last analysis, this merely involves transferring the kind of judgment involved in eye-fitting a smooth curve to a mathematical expression which will, in place

of the eye, formally express the final trended curve.

Several types of mathematical formulae were investigated for this purpose. An inspection of the data upon which the diversion studies were based indicated that a Gompertz exponential curve in most cases would give a better fit than other types of growth curves. The Pearl - Reed, or logistic, curve was considered but not adopted because its shape proved to be unsuitable. The Pearl-Reed Curve approaches its asymptotes more gradually than does the Gompertz Curve and hence is flatter at the extremes; for this reason it tended to give a poorer representation of the actual data. A subordinate, but cogent, objection to use of the Pearl-Reed Curve was that the mathematical manipulations in the computation of the curve equation involved raising the Y values to higher powers. Since the Y values were expressed as reciprocals (decimals), this process reduced them to such infinitesimal proportions that they become unusable. The plotted grouped data of these 19 time-ratio diversion graphs exhibited a shape and slope similar to a mirrored or reversed Gompertz Curve. In order to adapt the standard form of the Gompertz Curve exponential formula to the subject matter, the reciprocals of the time-ratios were calculated for application with that standard formula.

The resulting diversion curves were tested as to degree of association by index of correlation and as to variability of plotted data about the refined curve by standard error of estimate. For the curves involving trip data of greatest importance to rapid transit travel estimates, (such as peak-period work trips and C.B.D.-oriented trips) correlation indices against grouped data of higher than 0.9 were generally obtained. Had these correlation indices been calculated against individual scattered points, each representing a single zone-to-zone movement, such indices would, of course, have been lower. However, there appears to be some evidence to suggest that measuring correlation against grouped data plotted to rather small increments of time-ratio should, when all factors are considered, have statistical validity.

TABLE 1

RESEARCH IN MODAL TRAFFIC DISTRIBUTION FORECASTS

Semi-Final Transit Traffic Diversion Curves Developed by Regression Analysis and Tested for Correlation and Variability

(Measurement Basis: Time-Ratio)

For Use With Basic Traffic Data	Diversion Curve Graph Number	Trip-Terminal Orientation	Trip Purpose	Time and Direction of Travel
I	1	C	W	P
I	2-2A	C	O	P
I	3	C	W	Q
I	4	C	O	Q
I	5A	N	W	P
I	6-6A	N	O	P
I	7	N	W	Q
I	8	N	O	Q
II	9	T	T	R
II	9A	C	T	R
II	9B	N	T	R
III	10	T	W	R
III	10A	C	W	R
III	10B	N	W	R
III	11	T	O	R
III	11A	C	O	R
III	11B	N	O	R

LEGEND

I —Regional (non-integral) Bay Area O-D data obtained in 1954 and updated in 1959 A.A.W.D.

II —Internal San Francisco and Internal East Bay O-D data obtained in 1946-7, checked and updated to 1959 A.A.W.D.

III—1975, A.A.W.D. Regional Bay Area Synthetic O-D data developed in Gravity Model Analysis in 1959.

C —For trips with one or both trip terminals in the major C.B.D. of San Francisco and/or Oakland.

N —For trips with both terminals in other locations.

T —Total (or All)

W —Work

O —Other

P —Peak-period peak-direction travel.

Q —Non-peak-period-peak-direction travel.

R —24-hour travel

Origin-Destination Data

Table 1 lists the 17 consolidated semi-final graphs from which diversion curves were developed by regression analysis and tested for correlation and variability. It was necessary to develop such a variety of curves because the total of the rapid transit traffic assignments involved three sets of Bay Area O-D data, each in somewhat different tabular form with respect to breakdown by categories of trip. In addition, some of the curves were developed as guides in checking the validity of all of the curves employed in a single set of traffic data. Eight of the semi-final curves were associated with the regional O-D data collected in the 1954 Rapid Transit Commission study, where such breakdowns as peak-off-peak, work-other purpose, and C.B.D.-Non - C.B.D. were readily available. Three of the semi-final curves were associated with the internal trips made solely within San Francisco or solely within the ten East Bay cities. These trip data were obtained, not from the 1954 field surveys, but by a comprehensive updating of the 1946 - 47 Bay Area Metropolitan Traffic Survey. These data were not divided in the available tabulations by either purpose of trip or time of day. The only diversion curve separation which could be made for these trips was whether or not they involved one or both trip terminals in the San Francisco or Oakland C.B.D.s.

The basic Bay Area O-D data discussed so far were obtained from the 1947 and 1954 field surveys and carefully updated as part of the District's rapid transit study to the 1959 annual average weekday level. It was recognized, however, that in particular the rapidly growing peripheral sections of the Bay Area would experience considerable shifts in the patterns of its regional interurban traffic by the time the rapid transit system had experienced a period of seasoned operation. Accordingly, the target year 1975 was selected for a synthetic origin-destination survey of regional interurban trips within the five central Bay Area counties to be served by the Rapid Transit District. A mathematical gravity model was developed, tested against 1954 O-D patterns, and then employed

to predict the generation and distribution of regional traffic volumes between various cordoned sections of the Bay Area. The 1975 O-D trip forecasts were in terms of two trip purposes: commuter and all-other. The remaining six of the 17 semi-final diversion curve graphs, cited above, were developed to predict 1975-level rapid transit traffic diversion from this base of synthetic O-D trips, as an intermediate step in projecting such traffic for future periods.

Development of Final Curves

At this stage, the semi-final diversion curves were subjected to several progressive stages of testing, consolidation, and refinement before actual application in the traffic assignments. Because of basic similarity between several of these curves and the fact that certain of them had been developed for checking purposes only, considerable consolidation could now be effected, in order to limit further study to those curves actually to be employed in traffic diversion. Four curves emerged for use with updated 1959-level regional O-D volumes. Two curves became available for updated 1959-level internal San Francisco and East Bay O-D volumes. Four curves were selected for application with 1975-level regional synthetic O-D volumes.

The first independent test of their validity was made by constructing similar diversion curves from traffic data in other principal regional corridors in the Bay Area, such as Marin to San Francisco, East Bay and Concord to San Francisco, regional movements to Oakland, and local East Bay movements to Oakland. In those cases where a valid basis for comparison with the Peninsula laboratory data existed, reasonable checks on the validity of the Peninsula diversion study were obtained. However, in most of the corridors where such checks were performed, there were serious limiting conditions which precluded results indicating close comparability. In fact, the existence of these conditions was the reason why these other corridors had been excluded from the Peninsula study. Among the limiting conditions was the frequent occurrence of zone-to-zone movements of such small volume (particularly of transit trips) that the stability of the statistical basis for such research was impaired. In addition, the acute Bay Bridge traffic congestion, poor public acceptance of the former Key System Transit Lines, and a history of drastic decline in the Key System's Transbay patronage in the previous 15 years greatly limited the effectiveness of checks in the Transbay corridor of the validity of the research yielded by the Peninsula corridor.

As a separate check, selected transit and highway diversion curves developed in studies by others were plotted on a graph shown as Figure 2 herein. Included were transit traffic diversion curves developed in the Chicago Transportation Usage Study, as well as those developed and employed in recent studies in Washington, San Francisco, Southern New Jersey, and Toronto. The U. S. Bureau of Public Roads' curve for predicting vehicular traffic on the Interstate System and the A.A.-S.H.O. curves for use with urban freeways and urban major streets were also plotted. The semi-final diversion curves developed from the Peninsula study were plotted against the curves from these other studies as well as against the comparability check curves developed, as previously described, from observed data in sections of the Bay Area other than the Peninsula.

Following these steps the process of finalizing the diversion curves to predict Bay Area rapid transit traffic could then be undertaken. It was borne in mind that the semi-final curves had been developed largely on the basis of 1954 average weekday traffic in the San Jose-Peninsula-San Francisco corridor but that the final curves would be applied to estimate rapid transit traffic throughout the Bay Area, each part of which would have somewhat different characteristics. Travel conditions by both automobile and transit within the Bay Area by the time the proposed rapid transit system is in

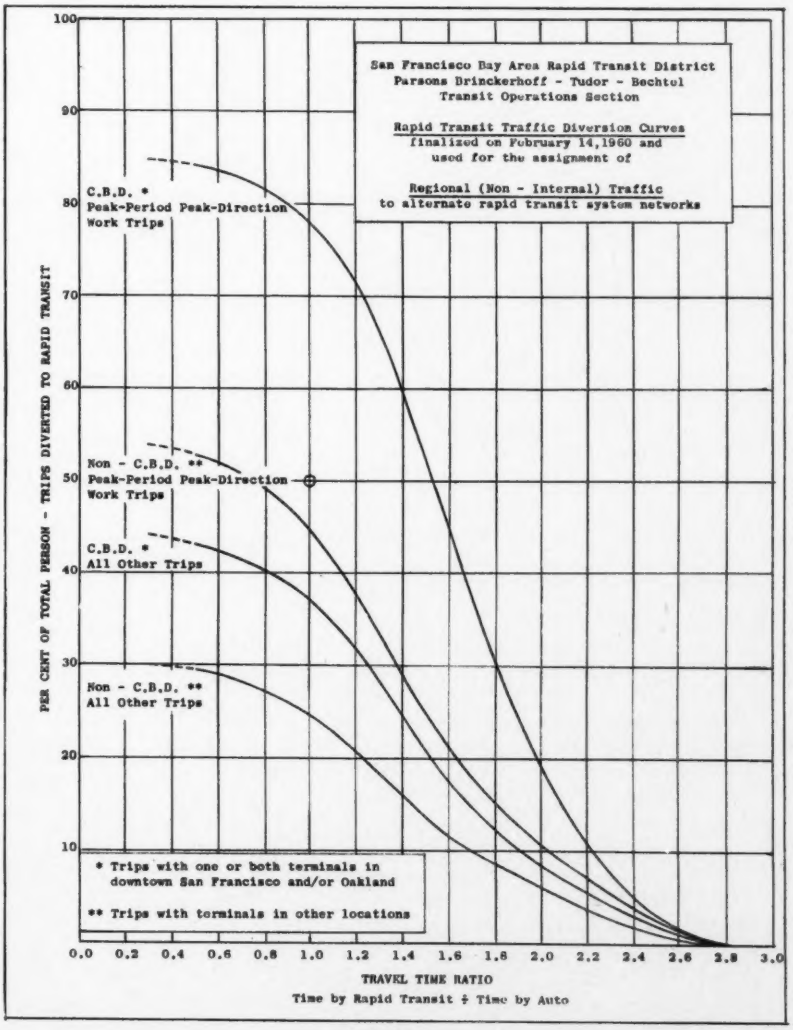


Figure 3

fully seasoned operation may be assumed to be somewhat changed from the case of the Peninsula in 1954. The full program of future regional highway and freeway improvements projected by the California Division of Highways was taken into careful consideration. The rapid transit program calls for a modern system to be in operation by 1967 with comprehensive feeder connections and integration with existing Bay Area transit systems. Delivery of passengers will be much improved not only in the Central Business Districts of San Francisco and Oakland but also in most of the regional residential areas and business sub-centers which the system will serve. The ability of rapid transit to collect passengers by feeder buses, parking, kiss-and-ride, etc., may also be assumed to be greatly improved over conditions existing at the time of collection of the basic data for this research.

The time-ratios between which data for most of the trips of interest were situated in the 1954 Peninsula corridor studies would in general become significantly lower in the future, as the balance of advantage in travel time improves with the introduction of a truly modern transit system. Thus, the semi-final curves developed from the Peninsula laboratory often did not have strong supporting data in the time-ratio range below 1.0, because few interurban trips in 1954 could be made to San Francisco with such low time-ratios. With direct rapid transit delivery from the Peninsula into downtown San Francisco by means of several stations along Market Street, and with acceleration and speed greatly improved over existing transit facilities, it is evident that future time-ratios, particularly for peak-period interurban trips, could be significantly reduced. As a measure of conservatism, however, where the plotted basic data in the semi-final diversion curves tended to become weaker in the lower time-ratios, the regression analysis was performed in such a manner that the resulting smooth curves tended to become level or asymptotic in their upper limits on the graphs shortly to the left of the point of diminishing support from such basic 1954 data.

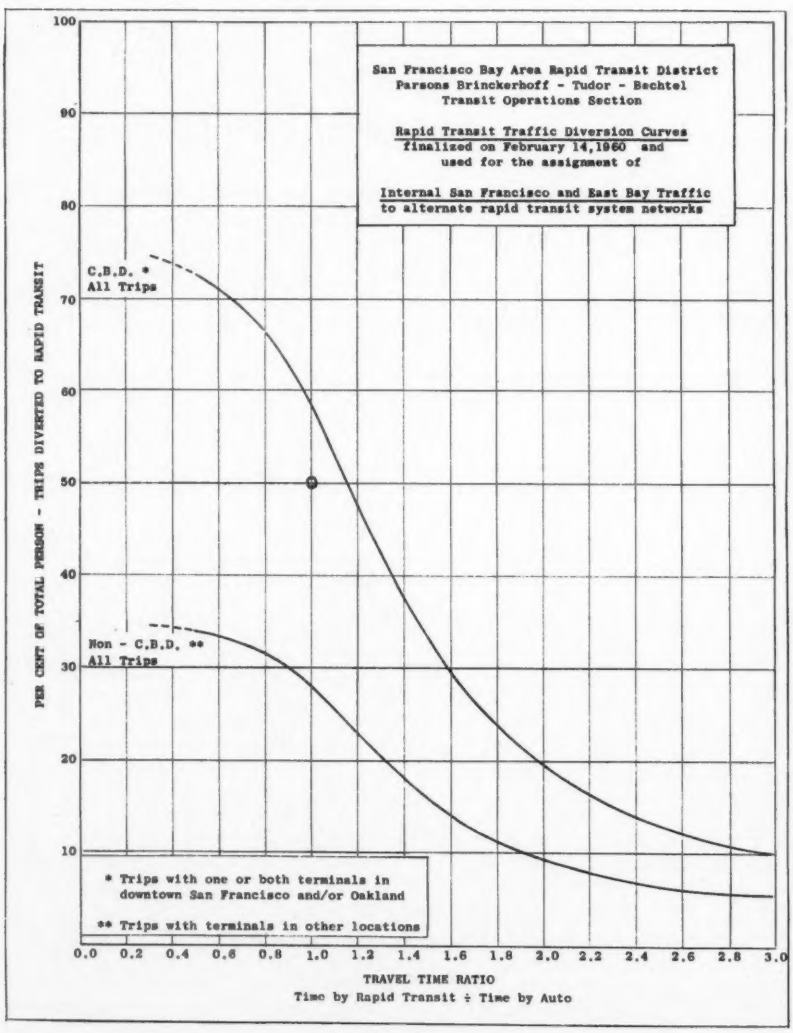

San Francisco Bay Area Rapid Transit District
Parsons Brinckerhoff - Tudor - Bechtel
Transit Operations Section
Rapid Transit Traffic Diversion Curves
finalized on February 14, 1960 and
used for the assignment of
Internal San Francisco and East Bay Traffic
to alternate rapid transit system networks
C.B.D. * All Trips
Non - C.B.D. ** All Trips
PER CENT OF TOTAL PERSON - TRIPS DIVERTED TO RAPID TRANSIT
100
90
80
70
60
50
40
30
20
10
* Trips with one or both terminals in downtown San Francisco and/or Oakland
** Trips with terminals in other locations
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0
TRAVEL TIME RATIO
Time by Rapid Transit ÷ Time by Auto

Figure 4

Several steps were involved in finalizing the diversion curves, and each step was checked against preceding ones, as well as against the plotted data from the Peninsula laboratory, from other sections of the Bay Area, and from the selected curves developed in other metropolitan areas. The final curves rest soundly on the foundation of basic data and analysis obtained from experience within the Bay Area, particularly in the Peninsula corridor. The curves and studies from other areas, however, were valuable guides in checking and accounting for the many variables which tend to influence the shape, slope, range, and position of rapid transit traffic diversion curves in general.

Description of Final Curves

A set of two graphs, shown in Figures 3 and 4, portray the final rapid transit traffic diversion curves as employed in the basic traffic estimates for the engineering reports submitted to the Transit District in May and June of 1960. The graph in Figure 3, with four curves, is for use with regional interurban traffic volumes. The graph in Figure 4, with two curves, is for use with internal San Francisco and internal East Bay traffic.

In Figure 3, the highest curve is for valid peak-period, peak-direction work trips of interest, with either or both trip terminals in downtown San Francisco or downtown Oakland. The second highest curve is for valid peak-period, peak-direction work trips of interest, with neither trip terminal in downtown San Francisco or downtown Oakland. The third curve is a companion to the first; it is used for "all other" valid trips of interest having either or both trip terminals in downtown San Francisco or downtown Oakland and not covered by the first or highest curve on the graph. The fourth or lowest curve complements the second; it is for "all other" valid trips of interest having neither trip terminal

in downtown San Francisco or downtown Oakland. Together, these four curves cover all categories of regional interurban trips of interest in the basic rapid transit traffic assignment analysis.

In Figure 4, the upper curve is for all valid trips of interest with either or both trip terminals in downtown San Francisco or downtown Oakland. The lower curve complements the upper in that it is for all other internal trips, i.e., those having neither trip terminal in downtown San Francisco or downtown Oakland. On each graph, the interception of the horizontal line representing 50 per cent diversion with the vertical line representing 1.0 (or equal) time-ratio, is indicated by a circle.

Several comments on the significance of the family of curves developed in this diversion research study appear in order. In the first place, the affinity to transit of those regional interurban work trips which occur in the peak period and peak direction of weekday travel, and which have either or both trip terminals in a major central business district, is clearly evident. At equal time-ratio, some 77 per cent of the total of such trips of valid interest are estimated to be diverted to rapid transit. Of course, only trips falling within a tributary traffic territory defined by reasonable feeder travel time to rapid transit stations are trips of valid interest in the assignments. The upper asymptote of this curve, falling at about 85 per cent diversion, illustrates that even in this trip category there are a number of travelers who, regardless of the favorability of the time-ratio for transit travel, would continue to use their automobiles because such vehicles are essential by reason of their work or other consideration. On the other hand, the lower asymptotes of all of the regional diversion curves fall at zero per cent diversion. This substantiates the contention that, for trips between suburban or exurban areas and major central business districts, there are practically no travelers who are so transit-oriented that, regardless of how high the time-ratio becomes, they would not eventually resort to automobile transportation. Families who live in the suburbs and exurbs almost always have some form of automotive transportation available and generally own one or two cars themselves. However, on the internal or urban diversion curve graph (Figure 4), as has been found in other urban areas, there does exist a core of transit-oriented trips which will be made by transit generally regardless of the unfavorability of the time-ratio. Curves for such trips generally approach their lower asymptotes at levels between 5 and 15 per cent diversion.

It is also of significance that those regional interurban peak-period peak-direction work trips which are not oriented to either major C.B.D. have a considerably lower potential for diversion to transit than do those with major C.B.D. orientation. The potential for this second category is still high enough, however, that at equal time-ratio some 44 per cent of total person-trips would be diverted to transit. Trips which do not fall in the category of peak - period peak - direction work trips have, as can be expected, a much lower potential for diversion to transit. Thus, the non - C.B.D. - oriented trips of this category are expected to yield only some 24 per cent diversion at equal time-ratio.

The Peninsula study was concerned with relatively long-length regional interurban trips to San Francisco from the Peninsula corridor. With the exception of the data employed in the comparative check of this research made for local East Bay trips into Oakland, available Bay Area data did not generally provide a detailed foundation for determining the internal traffic diversion curves shown in Figure 4. East Bay local trip data were important in forming the lower halves of the two curves shown in Figure 4, but to the left of approximately 1.5 time-ratio increased weight was given to the two time-ratio diversion curves, previously discussed, from the Chicago Transportation Usage Study (Curves 2 and 3 in Figure 2). The final curves used for the internal San Francisco and East Bay traffic estimates were also checked against research data from Washington, Toronto, and other areas. Again, it will be noted from Figure 4 that trips with either or both trip terminals in a major central business district such as San Francisco or Oakland have a considerably higher affinity for diversion to transit than is the case with trips having neither trip terminal in such a major central business district. At 1.0 time-ratio, C.B.D.-oriented internal trips of valid interest to rapid transit are estimated to yield some 58 per cent diversion to transit. This compares with a 62 per cent figure for the Chicago Transportation Usage Study curve in which only work trips to and from the C.B.D. were considered (Curve 3 in Figure 2). Because of the limitations of the tabulated Bay Area Metropolitan Traffic Survey data, the internal traffic diversion curves had to be developed for "all trips" without breakdown by purpose or time of day. However, the great majority of weekday trips to a major C.B.D. and of interest to rapid transit have work or business as their purpose. It is not surprising, therefore, to find that the Bay Area internal C.B.D. curve for "all trips" (Figure 4) is in general only slightly lower than the Chicago Study C.B.D. curve for work trips. Internal trips with neither trip terminal in a major C.B.D. are estimated to have a much lower affinity to transit than those with C.B.D. orientation. At 1.0 time-ratio, only 28 per cent of all non-C.B.D.-oriented person-trips of interest would be so diverted.

Summary

The evidence of the research clearly indicates the importance of separating the total volume of trips of interest into those with and without C.B.D. orientation, into those with and without peak-period peak-direction status, and by purpose of trip. When the total volume of trips are divided into such separate categories and separate diversion curves are developed from pertinent basic data for each such category, studies of rapid transit traffic diversion are subjected to a considerably more formalized and scientific procedure than has previously been the general practice in such estimates. The study further confirms the value of time-ratio as a measurement basis in simple correlation analyses of modal traffic distribution.

There are important possibilities for further research and study in this significant field. The results of such continuing research could be most productive and valuable for future transportation planning studies in all metropolitan areas. Should resources become available, it is the intention in the Bay Area to broaden and intensify this modal traffic distribution research program in the future. Among the most important possibilities for further investigation are multiple correlation analyses; a separation of total trip volumes into still more, or regrouped, trip categories; and particularly the sepa-

(Continued on page 54)

LET'S ANALYZE IT!

Misinformation about highway planning and the impact of highways on metropolitan and urban development is being widely spread . . . As just one example of misinformation that gains wide circulation is the assertion in national advertising and elsewhere that it takes twenty lanes of freeway to move as many people in an hour as can be moved on one rapid transit track. This statement has gained wide acceptance judging by the extent to which it is repeated by persons who evidently have not analyzed it.

Let's analyze it.

The figure of 40,000 persons is used as the number that *can* be moved on one rapid transit track. That we can accept. It can be done, even if it seldom is, for few indeed are the areas in which 40,000 persons wish to go from one place to another on one rapid transit track in an hour. But let us accept the figure.

Now we do not design freeways to carry 2,000 vehicles per lane per hour, but many do carry that much and more. So if we take 2,000 vehicles as the number that can and do use a freeway lane in one hour, then it would take 20 lanes to accommodate 40,000 vehicles, or 40,000 persons if each vehicle had only one occupant, the driver. So that must be the basis of the comparison. But we know that many vehicles have more than one occupant, so if 20 lanes are required, then a lot of vehicles have to be driverless—a situation still somewhat beyond our present technology.

But to be more realistic, suppose we assumed the more nearly normal occupancy in rush hours of 1.8 persons per car, or 3,600 persons per lane per hour. Then it would require 11 lanes. The 11 lanes would provide a more convenient service of course, because they would not be side by side in a single line but would diverge in perhaps three lines to serve a sector instead of a strip.

Still we have no real comparison, for we are still comparing what transit *could* do with what private vehicles *actually* do. Thus to be fair we should fill the private vehicles, perhaps not to their capacity but, say, just to five persons per vehicle. All would have seats, of course, in contrast to those on the transit train. With five per car, then 10,000 persons per lane per hour would be possible and the lane requirement for 40,000 persons is reduced to four lanes, certainly not an extravagant number.

But we are still a long way from a true comparison because the transit statement compares transit trains with private cars, not buses. Suppose we were to transport the 40,000 people in buses. Then, at 55 per bus, some 700 buses would be required, well under the capacity of a single freeway lane. And as evidence of realism in this figure, 20,000 to 25,000 persons per hour are regularly moved in buses in a single lane of the Lincoln Tunnel with ample room for many private cars as well.

But when all is said and done, what good is such a comparison, anyway? Are we more interested in what can be done *with* people or *to* people, or what people probably *will* do? And to what degree should this comparison of people passing a point in a single hour be the determinant of the desirability, or even the efficiency, of a facility?

What about the other twenty-two hours in the day aside from the morning and evening rush hours? Over 300,000 people move over the Hollywood Freeway on a typical weekday. What other transportation facility can make that statement?

What about the vehicle-miles or passenger-miles per mile of track or lane, as against the number passing a point? Here the greater uniformity of freeway use from end to end weighs in heavily in its favor.

What about Sunday traffic? Freeways often carry more people on week-ends than on weekdays, while transit tracks lie virtually idle.

What about time of trip from end to end? Rail transit can claim high speeds between stops, but what about stops at stations, time lost in waiting for trains, time spent in waiting at transfer points, and time spent in walking from transit vehicle to home or office or store?

And finally, what about the movement of goods? Very few crates of lettuce are delivered by subway to quote AASHO's philosophical Executive Secretary.

Unfortunately, we have the answers to only a few of the questions on this list, and we seem to be unduly silent on those we can answer. But leaving aside entirely the question of desire of the people, and thinking only of so-called efficiency, why should we let the merit of an all-purpose transportation system be challenged on the basis of an hour or less in the morning and evening, five days a week, when the facilities are there to be used 24 hours a day and seven days a week? We have let ourselves and our whole urban highway program be placed on the defensive by an argument that touches only one facet of the problem of metropolitan area transportation, and one which has the hollowest of support.

—from an address "Urban Transportation Planning and the National Highway Program" by E. H. Holmes, Assistant Commissioner of Research, Bureau of Public Roads, before the Special Committee on Urban Planning Seminars, American Association of State Highway Officials 1960 Annual Meeting, Detroit, Michigan, December 1, 1960.

Traffic News

BPR to Give Approval Only to Signs from New Manual; Available Soon

A long step toward greater standardization of traffic signs, signals and markings has been taken with the approval of a revised Manual on Uniform Traffic Control Devices for Streets and Highways, and with the announcement by the Bureau of Public Roads that only such devices as conform to the new Manual will be approved for the Federal-aid highway systems.

The new standards, updated from 1948, are contained in a Manual drafted by the National Joint Committee on Uniform Traffic Control Devices, and recently approved by the Committee's member organizations, the American Association of State Highway Officials, the Institute of Traffic Engineers, the National Committee on Uniform Traffic Laws and Ordinances, the American Municipal Association and the National Association of County Officials. The latter two organizations joined the National Joint Committee during the past year and are expected to lend added impetus to the modernization of traffic control devices throughout the nation.

The Manual reflects widely accepted and time-tested traffic control practices as well as the information provided by numerous studies dedicated to searching out the principles for safe and orderly movement of vehicles and pedestrians. First written in 1935, the Manual has been revised periodically to prescribe refinements in the design and application of control devices so urgently needed for effective guidance and management of traffic. This newest edition includes for the first time a major section dealing with standards for expressway signing, another on signing and marking for construction and maintenance operations, and a brief treatment of civil defense signing.

The Bureau of Public Roads actively assists the National Joint Committee in its work and has a responsible interest in seeing that the results are broadly applied. By existing Federal highway legislation and the terms of an order of the Department of Commerce, the signs, signals and markings installed on highways constructed with Federal funds (since December 20, 1944) are subject to approval by the State highway department with concurrence of the Federal Highway Administrator, who is directed to concur only in installations that promote safe, efficient highway use.

Concurrence in the new Manual was announced recently by Federal Highway Administrator Bertram D. Tallamy, who said: "As a matter of policy, the Bureau of Public Roads proposes to use its authority to approve, for the Federal-aid highway systems, only such traffic control devices as will conform to the new Manual. A reasonable time following the issuance of the revised standards will, of course, be allowed for the gradual replacement of any existing installations that may be made obsolete by the new Manual."

A most significant feature of the new Manual, in the opinion of many of the engineers who aided in its preparation, is that it eliminates many of the alternatives in traffic control devices that previously were permitted and substitutes a single standard. A notable example of this is the stripe to mark "no passing" zones. In the future, according to the new Manual, all such zones are to be marked with a yellow line to the right of the white center stripe. In the past some states used yellow and others used white.

Another case in which a single standard has been substituted for various options is in pedestrian signals. The new Manual provides that pedestrian signals shall be rectangular in shape and that the messages they carry shall be limited to WALK and DON'T WALK.

Generally the sizes of traffic signs specified in the new Manual are larger than those now commonly in use. This is to provide greater visibility particularly on multi-lane highways where driving is at higher speeds. The new Manual also specifies a standard size for signs rather than minimum sizes as was the case in the old Manual.

An aid to night driving provided for in the new Manual is the use of a white edge line to delineate the edge of the pavement from the shoulder. Such markings also will add to the safety and convenience of travel during

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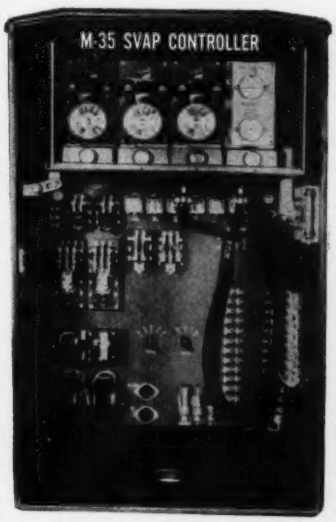

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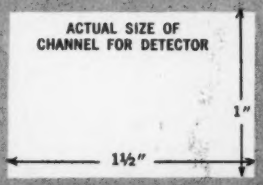

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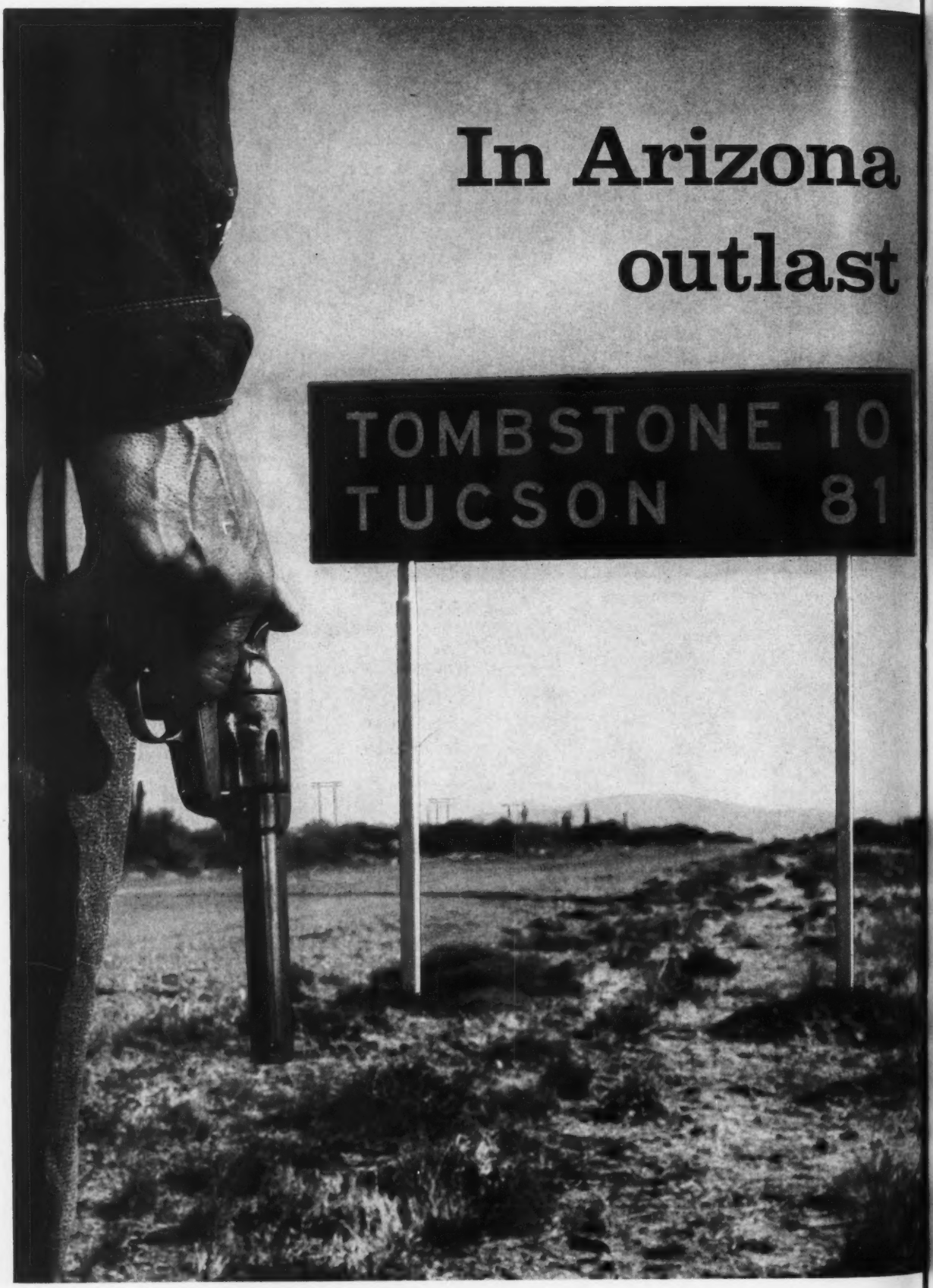
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overlaid plywood signs metal 3 to 1

SIGN REPLACEMENT WAS A REAL PROBLEM IN ARIZONA until the Highway Department switched to plywood. Trigger-happy motorists had been taking pot shots at metal signs. This led to rust, deterioration and often dangerously reduced legibility after only a few months of use. Then performance tests showed overlaid plywood's life expectancy was at least three times that of metal.

Now Arizona uses overlaid plywood for 85% of its signs. Vandals still shoot at them. But plywood stands up to both deliberate and accidental abuse without losing legibility. Bullets go right through without shattering the sign face. There's no corrosion problem; repairs are made quickly.

Overlaid plywood withstands Arizona's weather, too, with its extremes of heat, rain and snow. The plywood is completely waterproof, and the smooth, durable plastic-like surface makes an ideal base for reflectorized material.

Besides saving on maintenance and replacement, plywood signs are simple and inexpensive to fabricate. In Arizona's sign shop, a production-line process is used to make about 70 different basic signs, most with reflectorized legends.

FOR MORE INFORMATION (detailed specifications, application data, etc.) write:
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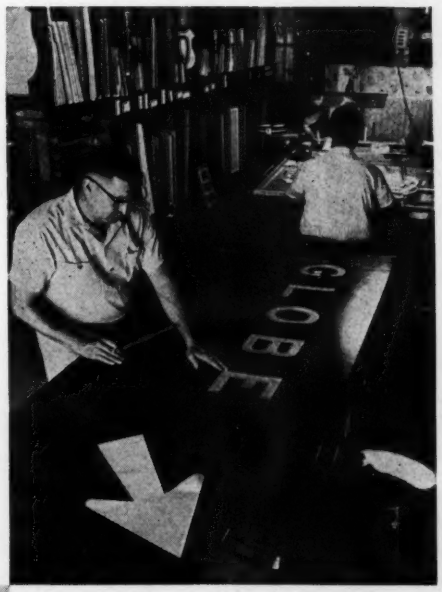


Plywood signs on Arizona's highways not only resist abuse from vandals and a rugged climate, but are attractive and easy to read. Fabrication in the state's sign shops is simplified because standard-sized panels of plywood are easy to store and easy to cut to required sizes and shapes. Above, reflectorized letters are applied to an overlaid plywood sign.

fog or rain and will serve to keep heavy vehicles off the shoulder. Use of edge markings is on a permissive rather than mandatory basis.

The new Manual calls attention to the desirability of making greater use of easily understood symbols on traffic signs in preference to word messages. It points out that such conventional symbols as the directional arrow, the curve arrow or the intersection diagram are instantly recognizable. The increasing exchange of international travel also makes more symbolization desirable as symbols are widely used in Europe and in Canada and Mexico. The Joint Committee which authored the Manual calls for initiation of a program of research to determine the extent to which symbols can be used to advantage on traffic signs.

For freeways and expressways the new Manual provides for larger and higher signs than for conventional roads and streets. It specifies the use of overhead signs in locations where heavy traffic, terrain or highway design features impair the visibility of signs located along the roadside. Also provided for are reflectors on posts at regular intervals along the edge of the road to more clearly indicate the alignment of the highway at night.

The new Manual provides for a solid white channelizing line to discourage lane changing on the part of drivers.

The new Manual continues the practice of reserving certain sign shapes for particular meanings, such as the octagon shape for STOP, the triangular shape for YIELD and the crossbuck for railroad crossings.

Many of the changes in the Manual are technical in nature and relate to the conditions under which control devices should be employed by the officials responsible for traffic operations, and with the size and location of such devices. To the fullest extent possible the Committee responsible for preparation of the Manual sought to avoid drastic changes in existing sign, signal and marking practices that would create confusion for motorists.

One innovation that may come into general use as a result of the new Manual is a system of lane control signals on streets that have reversible unbalanced lane operation to favor the predominant traffic flow at peak hours. Such signals will facilitate unbalanced operations by notifying motorists which lanes are operating in-bound and which out-bound. The lane signals will be suspended overhead in each block of a city street. A green arrow will mean the particular lane is open to traffic and red "X" will mean it is closed.

The current nationwide highway modernization program will require detours around construction sites in many locations. As a protection to both motorists and workmen, the new Manual contains an entire new section for traffic control devices at construction sites for use by state officials or by contractors as appropriate.

The current Manual has its origins back in 1927 when the American Association of States Highway Officials drafted and published the first set of uniform standards for signs, signals and markings on rural highways. This was followed, in 1929, by the publication of a similar set of standards for application on urban streets by the National Conference on Street and Highway Safety. Later these two organizations combined their recommendations in a single manual, published in 1935.

"The new edition of the Manual on Uniform Traffic Control Devices is expected to make a valuable contribution to the safe and efficient use of the new highways being constructed in the Federal-aid program," Tallamy said. "Also, the quality of traffic service on our older streets and highways should benefit greatly from the revised standards applicable to highway signs, pavement marking and traffic signals."

To foster widest and earliest possible application of the new Manual, the Bureau of Public Roads has stated that Federal-aid funds may be used for sign modernization on a statewide or selected system basis. Funds may also be used for engineering studies to determine needed changes in signing practices. A pilot study of this type is now being carried on by the Iowa Highway Department.

The current edition of the Manual sets forth the value of uniformity as follows:

"Uniformity of traffic control devices simplifies the task of the road user because it aids in instant recognition and understanding. It aids police, courts and road users by giving everyone the same interpretation. It aids public highway and traffic officials through economy in manufacture, installation, maintenance and administration.

"Simply stated, uniformity means treating similar situations in the same way. The use of uniform traffic control devices does not, in itself, constitute uniformity. In fact, using a standard device where it is not appropriate is as objectionable as using a non-standard device.

"The decision to use a particular device at a particular location must be made on the basis of an engineering study at the location."

The National Joint Committee on Uniform Traffic Control Devices which had charge of preparation of the new Manual is composed of seven representatives of the American Association of State Highway Officials, seven representatives of the Institute of Traffic Engineers, seven from the National Committee on Uniform Traffic Laws and Ordinances, and two each from the American Municipal Association and National Association of County Officials. Chairman is E. H. Holmes, Assistant Commissioner, U. S. Bureau of Public Roads.

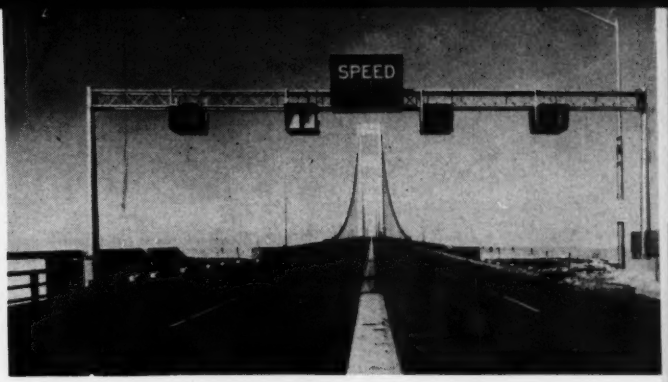
Copies of the new Manual on Uniform Traffic Control Devices for Streets and Highways will be available to public officials, motorists and other interested persons from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. as soon as possible.

Whitton Appointed Federal Highway Administrator

Rex M. Whitton, formerly chief engineer of the Missouri State Highway Commission, is the new Federal Highway Administrator. Named to this position by President Kennedy, Mr. Whitton is the administrative head of the Bureau of Public Roads in the U. S. Department of Commerce. He succeeds Bertram D. Tallamy, who has headed the national highway program since 1957, and who is entering the consulting engineering field.

Mr. Whitton, 62, has dedicated his career to highway improvement. He has been connected with the Missouri State Highway Commission since 1920, the same year he graduated from the University of Missouri with a degree in civil engineering. He became chief engineer of the Commission in 1951.

Mr. Whitton is a former president of the American Association of State Highway Officials and chairman of the Highway Research Board.



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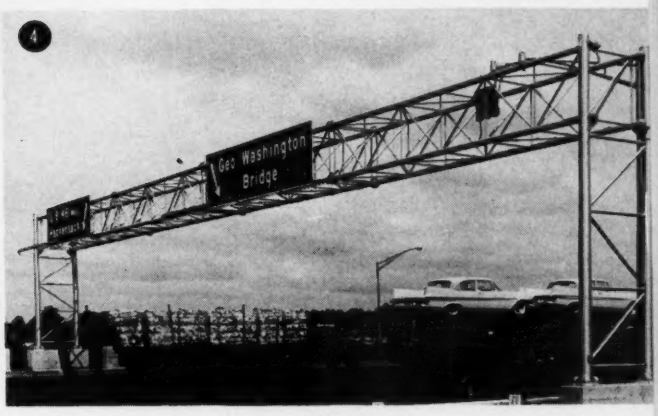

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LOCATION: Interstate Route 40

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Twenty of the 24 resident graduate students in transportation engineering currently at Northwestern University are shown. They are (left to right, front row) V. Melkonian, Lebanon; B. Betz, Illinois; C. Guin, New York; J. Zuniga, Nicaragua; M. Gersten, New York; H. Schwartz, Austria. Second row, J. Stowers, U. S. Bureau of Public Roads; C. Worrall, England; C. Podesta, Italy; E. Carter, Virginia; and K. Hanawa, Japan. Third Row, Dr. Paul Shuldiner; P. Fargier, France; J. Pipan, U. S. BPR; and Dr. D. S. Berry. Fourth row, R. Millburn, Hong Kong; J. Robles, Surinam; E. Francois, Ghana; G. Satterly, Michigan; and D. Kovarik, U. S. Army Transportation Corps. Top row, A. Aarvala, Finland; R. Sagen, Norway. Not shown are W. Mader, army transportation corps; H. Schwar, South Africa; J. Wattelworth, Illinois; and C. Grove, South Africa.

N. U. Announces '61-'62 Fellowships

Three National Defense Graduate Fellowships will be available at Northwestern University for graduate study in Urban Transportation Planning beginning in the fall of 1961, according to Dr. Donald S. Berry, Professor of Civil Engineering at Northwestern.

Each Fellowship, normally a 3-year award, provides $2,000 for the first year, plus $400 per dependent, plus tuition. In the second and third years the base amount of the award is increased slightly. Eligibility is limited to U. S. citizens or persons intending to remain in this country, with a B. S. degree, who desire to work for a Ph.D. degree. Preference is given to applicants who are interested in university teaching.

There are other fellowships, assistantships and teaching assistantships available at Northwestern, according to Dr. Berry. Any persons interested are invited to write to him for further information.

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Yale Fellowships Available for 1960-61

The Bureau of Highway Traffic at Yale University has announced the availability of fellowships for the 1961-62 academic year to be awarded to qualified graduate engineers who are citizens of the United States and would like to enter the profession of traffic engineering as a career.

The fellowships cover a full academic year of graduate study, starting in September, 1961 and terminating the following June. They provide a living stipend of $1,400.00 disbursed at the rate of $175.00 per month for a period of eight months, while a student is enrolled. The fellowships also provide the tuition of $1000, which amounts to a total value of $2,400.00 for each fellowship. The fellowships are made available to the Bureau through grants from the Automotive Safety Foundation, the Esso Safety Foundation, the Insurance Institute for Highway Safety and The James S. Kemper Foundation.

The Bureau also offers tuition scholarships to qualified municipal and state highway engineers who will receive financial aid from their employers while undertaking the graduate work. This arrangement is considered by many employers to be a form of in-service training.

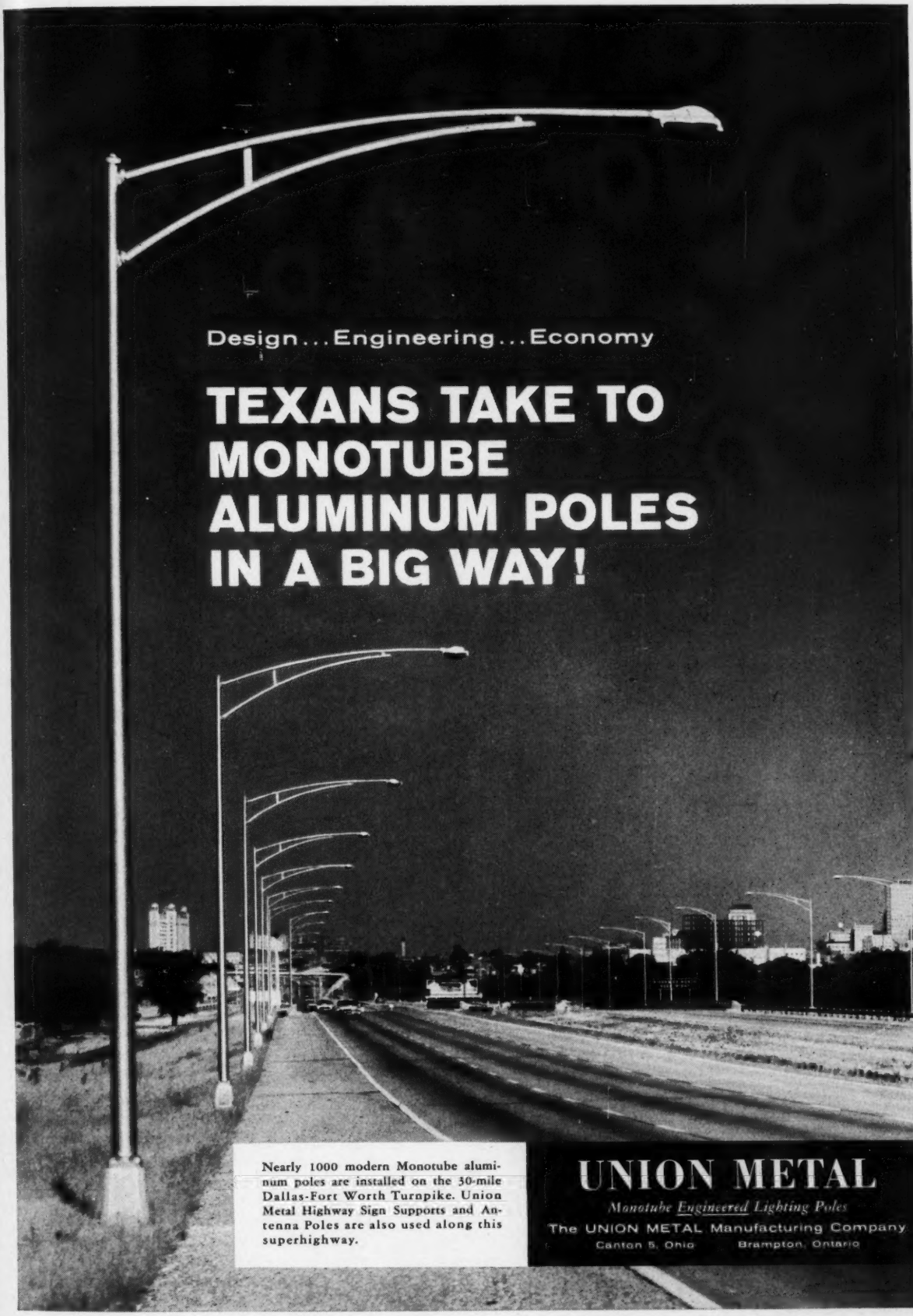
The Bureau has trained about 600 professional traffic engineers. Most of these graduates hold responsible traffic engineering positions in city government and state highway departments as well as commercial agencies. The academic year of traffic engineering study consists of two full semesters of classroom work, laboratory and individual research, required reading, field problems and seminars. The courses include (1) traffic characteristics and measurements, (2) traffic regulations and control devices, (3) highway planning, (4) highway location and geometric design, and (5) highway administration and finance. Experts in traffic and related fields from all over the country are invited to speak as guest lecturers at frequent intervals.

Applications for admission and further information may be obtained by writing to Mr. Fred W. Hurd, Director, Bureau of Highway Traffic, Yale University, Strathcona Hall, New Haven, Connecticut. Fellowships and scholarships are awarded to those applicants with highest qualifications. The closing date for filing applications is March 1, 1961. Previous experience in traffic work is not essential to become a successful candidate for a fellowship or scholarship when other qualifications are indicated.

Federal Safety Board Established by President

A Federal Interdepartmental Highway Safety Board has been created by executive order of the President. The order, issued in December by President Eisenhower, follows the terms of a recommendation made in the 1959 report of the Secretary of Commerce, "The Federal Role in Highway Safety."

The chairman of the board will be the Secretary of Commerce. Other members will be the Secretary of Defense, the Postmaster General, the Secretary of Health, Education and Welfare, the chairman of the Interstate Commerce Commission, and the Ad-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ministrator of General Services.

In addition to coordinating efforts, the new Board, the President said, will provide "Federal leadership and guidance of existing and future official activities that affect the safety of travel on public streets and highways."

In the executive order, the functions and duties of the new Board were described as follows:

"(a) To provide leadership to, and to coordinate the traffic safety aspects of programs carried on by, the departments and agencies of the Federal Government.

"(b) To evaluate the continuing needs in traffic safety research and to formulate plans, priorities, and programs for the conduct of or for assistance to the most urgently needed research through departments and agencies of the Federal Government.

"(c) To consult and cooperate with state and local officials having a public responsibility for traffic safety and their national associations, with the motor vehicle industry, and with other related interests in the development and improvement, and particularly in the application, of traffic safety standards in areas such as uniform traffic laws, enforcement practices, accident records, driver licensing, motor vehicle equipment and inspection, traffic engineering, and safety education.

"(d) To conduct continuing studies of national traffic safety needs as they relate to legislative and administrative actions by the Federal Government, and to report thereon.

"(e) To perform such other duties and functions as the President may direct to coordinate more effectively the policies, programs, and functions of the departments and agencies of the Federal Government relating to traffic safety, including accident reporting, and to insure an orderly relationship among Federal, state, and local traffic safety programs."

The Board was instructed to submit reports to the President, from time to time, on the national progress in traffic safety. The first report is to include determinations of the status of Federal legislative and administrative needs in the various areas of traffic safety, along with recommendations for executive or legislative action.

The President's Committee for Traffic Safety will serve as consultant and advisor to the Board.

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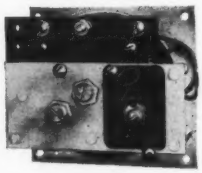

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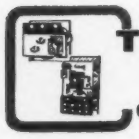

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New Appointments

Deen Moves to New Washington Agency

Thomas B. Deen (Assoc. Mem. ITE) has recently been appointed to the position of Highway Engineer (Traffic Planning) for the National Capital Transportation Agency in Washington, D. C. In his new position he is responsible for traffic and transportation planning studies for the new Agency, under the direction of Mr. Robert A. Keith, Director of Engineering Programs. The NCTA has been given the job of planning, designing, building and operating a rapid transit system for the Washington region.

Mr. Deen received his B.S. in Civil Engineering degree from the University of Kentucky in 1951. He did graduate work at the University of Chicago in 1952 and following military service with the Air Force attended the Yale Bureau of Highway Traffic (Class of '56) under a fellowship provided by the Automotive Safety Foundation. Mr. Deen has served as Assistant Traffic Engineer for Nashville, Tennessee, as Coordinator of the Nashville Metropolitan Area Transportation Study, and as Applied Science Representative for the IBM Corporation before accepting his new position. He is a registered professional engineer and a member of the National Society of Professional Engineers.

Bouman Named to Top Post in San Diego

Martin J. Bouman (Assoc. Mem., ITE) has been named Transportation and Traffic Engineer for the City of San Diego. He was named to this post following the resignation of Edward M. Hall. He had previously been Traffic Engineer and Associate Traffic Engineer in San Diego for six years.

Bouman studied at Stanford and at the University of Southern California, receiving his civil engineering degree at USC in 1949. He subsequently did graduate work at Southern California in the field of traffic engineering.

Following his college work, Bouman worked for a year with the City of Los Angeles, and then for four years with the traffic division of the Los Angeles County Road Department. Earlier he spent three and a half years with the Corps of Engineers, serving with an

Martin J. Bouman

engineer combat battalion of the 71st Infantry Division in the Rhineland and Central Europe campaigns of World War II.

A member of the Institute of Traffic Engineers for ten years, Bouman is currently vice president of the Western Section of ITE. He is a member of the American Public Works Association, and has been very active in committee work for the local APWA chapter.

Mascari Appointed Assistant City Engineer

John A. Mascari (Associate Member, I.T.E.) was recently appointed Assistant City Civil Engineer for the City of Indianapolis, Indiana, to succeed Mr. Forest M. Logan who has retired after half a century with the City of Indianapolis.

Mr. Mascari has been with the City of Indianapolis since 1946. Assigned to almost every function in the City Civil Engineer's office, he held the title of Design Engineer when he was transferred to the Bureau of Traffic Engineering in 1956. As Design and Planning Engineer for the Bureau of Traffic Engineering. Mr. Mascari was responsible for all of the field studies, investigations of requests and complaints, review of permits, intersection design and thoroughfare planning. He supervised the organization and training of a new field studies unit to gather factual data for all Bureau activities. Among his other major accomplishments were the design and installation of the first reversible lane operation in Indiana, and the design and preparation of supporting data for a five mile oneway pair, extending the city's system of oneway thoroughfares.

A native of Indianapolis, Mr. Mascari and his twin brother Mike, were

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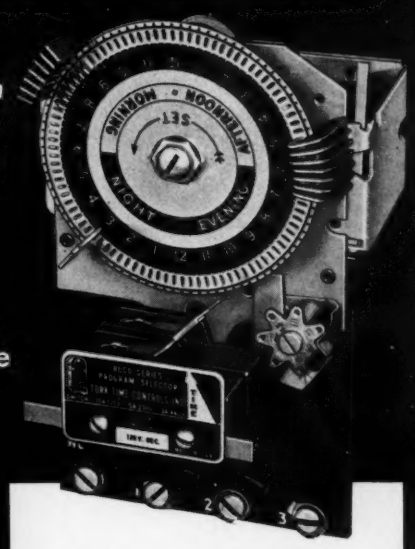

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- Can be set accurately . . . with 15 minute tabs, there's no depending on human element to slide ON-OFF trippers to operating times on dial.
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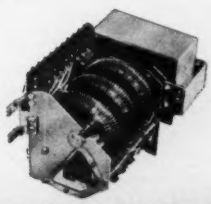

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John A. Mascari

well known for many years as track stars. The state record for the mile, set by him in 1940, was only recently broken. Shortly after graduating from high school, Mr. Mascari entered the service, and served for three years in the United States Coast Guard. After his discharge, and while employed by the City Civil Engineering Department, Mr. Mascari enrolled at the Purdue University Extension in Indianapolis with the objective of going into building construction. However, he found it necessary to withdraw at the end of two years because of family responsibilities. Mr. Mascari has completed short courses in Traffic Engineering at both Northwestern University and Purdue University and is an active member of the Indiana Section of the Institute of Traffic Engineers. He was recently elected to the Board of Directors of the Indiana Section of the American Public Works Association, and he is active in many local civic activities.

The duties of Design and Planning Engineer in the Bureau of Traffic Engineering are now being handled by Mr. Arthur G. Wake. Mr. Wake comes to this position with more than twelve years of experience with the State Highway Departments of Indiana and Wisconsin. Mr. Wake attended Purdue University, leaving the school of civil engineering in 1949 to accept a position in the Planning Division of the State Highway Department of Indiana. There his primary responsibilities included origin-destination studies and economic justification studies. For the past few years, Mr. Wake has been assigned to the planning of Interstate highways in Indiana, including location, preliminary design, traffic estimates and economic analysis. A registered professional engineer in Indiana, he is a member of the National Society of Professional Engineers. Mr. Wake is also active in many civic and fraternal organizations in Indianapolis.

McCracken Named Board Chairman of Insurance Institute

Dwight M. McCracken, vice president, Liberty Mutual Insurance Company, Boston, Mass., has been elected chairman of the board of governors of the Insurance Institute for Highway Safety.

He succeeds Thomas C. Morrill, vice president, State Farm Mutual Automobile Insurance Company, Bloomington, Ill. Mr. McCracken was elected for a one-year term.

Russell I. Brown was re-elected president of the IIHS and Richard O. Bennett was re-elected secretary-treasurer. Office of the IIHS is at 1710 H Street, N.W., Washington, D. C.

Re-appointed to the board of governors by the three sponsoring associations were:

Guy E. Mann, senior vice president, Aetna Casualty and Surety Company, Hartford, Conn.; James M. Crawford, vice president, Indemnity Insurance Company of North America, Philadelphia, Pa., and J. Harry Bibby, executive vice president, U. S. Fidelity and Guaranty Company, Baltimore, Md. (by the Association of Casualty and Surety Companies).

Mr. McCracken, Arthur S. Johnson, vice president, engineering, American Mutual Liability Insurance Company, Wakefield, Mass., and Chase M. Smith, senior vice president and general counsel, Lumbermens Mutual Casualty Company, Chicago, Ill. (by the National Association of Automotive Mutual Insurance Companies).

Mr. Morrill, Albert E. Spottke, vice president, Allstate Insurance Company, Skokie, Ill., and Howard Hutchinson, vice president, operations, Nationwide Mutual Insurance Company, Columbus, O. (by the National Association of Independent Insurers).

Ex-officio members of the board of governors are J. Dewey Dorsett, general manager of the Association of Casualty and Surety Companies, New York City; Vestal Lemmon, general manager of the National Association of Independent Insurers, Chicago, and Newell R. Johnson, general manager of the National Association of Automotive Mutual Insurance Companies, Chicago.

Messrs. McCracken, Spottke, and Crawford will serve on the Institute's executive committee during 1961, with Mr. McCracken as chairman.

The Insurance Institute for Highway Safety was established in January of 1959 by the three casualty insurance associations to combat motor vehicle accidents on an industry-wide front. The associations represent more than 500 companies which write about 80 per cent of the nation's automobile insurance.

Dale Humphrey to Automatic Signal

H. Dale Humphrey (Assoc. Mem. ITE) has joined Automatic Signal Division, Eastern Industries, Inc., at Norwalk, Conn., as Sales Engineer. Announcement of the move was made by Mr. Paul L. Green (Mem. ITE), Sales Manager.

H. Dale Humphrey

Humphrey goes to Automatic Signal from the Bureau of Traffic Engineering of the City of Indianapolis, Indiana, where he served as Traffic Signal Engineer since 1956. Prior to this he was with the Traffic Signal Division of the Bureau of Street Traffic for the City of Chicago. In his military service, from 1950 to 1952, he was with the Highway Section of the Transportation Research and Development Station, Ft. Eustis, Virginia.

Mr. Humphrey was graduated from Purdue University in 1950 with a B.S. in Civil Engineering. He also attended the Yale Bureau of Highway Traffic 1954-55. Humphrey is registered as a Professional Engineer in Illinois and Indiana.

Holmes Named Manager Highway Construction Marketing; LeCraw Appointed Assistant to Director, Market Development Division

Robert S. Holmes

Charles S. LeCraw, Jr.

Robert S. Holmes has been appointed to the position of manager, highway construction marketing, in the market development division of United States Steel Corporation, Pittsburgh, Pa.

Mr. Holmes coordinates the combined efforts and interests of the Corporation and its various divisions in support of the Federal Highway program and construction of the 41,000-mile Interstate system.

Mr. Holmes is a graduate of Georgia Institute of Technology and served for several years in the Alabama and Georgia Highway Departments. Following a year of specialized graduate training at the Yale University Bureau of Highway Traffic, he was assigned to the Pennsylvania Turnpike Commission as special highway engineer on the original 160-mile construction project.

Following six years of military service, Mr. Holmes became the first executive secretary for the Institute of Traffic Engineers and later became chief highway engineer for the Federal Civil Defense Administration. Recently he held the position of executive assistant to the president of Wald Industries, Huntingdon, Pa.

Mr. Holmes joined United States Steel as highway construction representative in 1956 and was promoted to assistant manager, construction marketing a year ago.

Mr. Holmes is a registered professional engineer, a member of the Institute of Traffic Engineers, the American Society of Civil Engineers and the Highway Research Board.

Charles S. LeCraw, Jr., has been appointed to the position of assistant to the director in the market development division of United States Steel Corporation, Pittsburgh, Pennsylvania.

Mr. LeCraw will serve in a coordinating capacity in the "Applications Development" field, working closely with all commercial department and research units of U. S. Steel in its continuing activity to assist customers in the improvement of existing products and the development of new products made of steel. Mr. LeCraw will work with outside design and consulting engineering firms as well as the U.S.S. Research Laboratory at Monroeville in U.S. Steel's continuing effort to provide this service to its customers.

A graduate of Georgia Institute of Technology and the Yale University Bureau of Highway Traffic, Mr. LeCraw has held various jobs in the engineering and construction field prior to joining United States Steel in 1955 as manager—building and construction industries, market development division.

He is a member of the Institute of Traffic Engineers, the American Society of Civil Engineers, the Engineering Society of Western Pennsylvania, and serves in various capacities with the Porcelain Enamel Institute, the Producers' Council, American Institute of Steel Construction and the American Iron and Steel Institute.

Some men have the reputation for being energetic when they're only nervous.

Job Changes

Jack A. Artale—formerly Senior Highway Designer with Goodkind & O'Dea, Consulting Engineers in New York City; is now Traffic Planning Engineer with the firm of Tippetts-Abbett-McCarthy-Stratton in New York City.

Donald E. Bass—formerly Traffic Engineer I with the Wyoming Highway Department in Cheyenne, Wyoming; is now Traffic Engineering Associate in the Department of Traffic for the City of Los Angeles, California.

Thomas M. Blalock—formerly Traffic Engineer with the Department of Public Works in Sunnyvale, California; is now Assistant City Engineer for the City of Fremont, California.

Paul C. Box—formerly Traffic Engineer with George W. Barton & Associates in Evanston, Illinois; is now Director of Engineering for the Skokie Engineering Department in Skokie, Illinois.

William E. Corgill—formerly Traffic Engineer with Wilbur Smith & Associates in Columbia, South Carolina; is now Assistant Director of the New York State Citizens Council on Traffic Safety, Inc., in New York City.

Lewis R. Coyle—formerly Traffic Engineer with Gannett, Fleming, Corddry & Carpenter, Inc., in Harrisburg, Pennsylvania; is now Highway Engineer for Program Planning with ICA serving as advisor to the Indonesian Highway Department in Bandung, Indonesia.

Cecil W. Hathaway—formerly Assistant Traffic Engineer with the Idaho Department of Highways in Boise, Idaho; is now Assistant Professor in the Department of Civil Engineering at the University of Idaho in Moscow, Idaho.

Arnold A. Johnson—formerly Assistant Traffic Civil Engineer with the Arizona Highway Department in Phoenix; is now Traffic Engineering Supervisor with the City of Phoenix, Arizona.

Louis G. Kisseleff—formerly Traffic Engineer with the Department of Legal Medicine at Harvard Medical School in Boston, Massachusetts; is now District Traffic Engineer with the Pennsylvania Department of Highways in Franklin, Pennsylvania.

Philip M. Linscott—formerly Chief Transportation Engineer with Dan-

iel, Mann, Johnson & Mendenhall in Los Angeles; is now Director of Traffic Engineering with the firm of Welton Becket & Associates in Los Angeles, California.

Michael R. Pender—formerly Traffic Engineer with Madigan - Hyland, Consulting Engineers in Long Island City, New York; is now Assistant to the Executive Vice President of the New York World's Fair 1964-65 Corporation in Flushing, New York.

Richard H. Pratt—formerly an Engineer with De Leuw, Cather & Co., in San Francisco, California; is now Traffic Engineer with the Public Works Department of the City of Mountain View, California.

Ralph E. Schofer—formerly Traffic Engineer with Hardesty & Hanover in New York City; is now Traffic Engineer with the District Department of Highways and Traffic in Washington, D. C.

Herman A. Sinemus—formerly Assistant Traffic Engineer with the City of Fort Wayne, Indiana; is now Traffic Engineer II with the City of Phoenix, Arizona.

James T. Young—formerly Senior Engineering Assistant of the Traffic Section of the Texas Highway Department in Fort Worth; is now the owner of Young Construction Co., in Stephenville, Texas.

Title Changes

Martin J. Bouman—is now Transportation & Traffic Engineer with the City of San Diego, California; was Traffic Operations Engineer.

Warren H. Brandt—is now Intersection Design Engineer with the Illinois Division of Highways in Effingham, Illinois; was Field Engineer of the Illinois Division of Highways in Elgin, Illinois.

Edwin F. Clark—is now Director of Highway Transportation Studies for the New York State Department of Public Works in New York City; was Director of Bureau of Highway Programming.

Philip G. Dierstein—is now Assistant Traffic Engineer with the Illinois State Toll Highway Commission in Hinsdale, Illinois; was Traffic Maintenance Supervisor.

J. Robert Doughty—is now Superintendent, Division of Utility Maintenance and Operation of the Cincinnati Department of Public Utilities; was Supervising Traffic Control Engineer.

Robert E. Dunn—is now Urban Highway Engineer with the Washington Department of Highways in Olympia, Washington; was Assistant Traffic Engineer.

George W. Easley—is now Highway Traffic Engineer with the Virginia Department of Highways, in Richmond; was Traffic Technician C.

James A. Gallagher, Jr.—is now Assistant Planning Engineer with the Washington Department of Highways in Olympia, Washington; was Assistant District Location Engineer in Vancouver, Washington.

William H. Gerstle, Jr.—is now Transportation Planner with the Port Development Department of the Port of New York Authority in New York City; was Highway Project Planner.

Melvin C. Pohlkotte—is now Signal Engineer of the City Bureau of Traffic Engineering in Indianapolis, Indiana; was Traffic Operations Engineer.

David B. Sampson—is now Traffic Engineer (Traffic Planning) with De Leuw Cather & Co. of Canada Ltd. in Toronto, Ontario; was Highway Engineer.

Roy B. Sawhill—is now Associate Professor of Civil Engineering at the University of Washington in Seattle; was Assistant Professor.

Paul M. Weckesser—is now Traffic Engineer with the New Jersey Turnpike Authority in New Brunswick, New Jersey; was Assistant Traffic Engineer.

Charles E. Zell—is now Senior Highway Engineer, Planning & Survey Department of the California Division of Highways in Sacramento, California; was Associate Highway Engineer.

ROLLA T. FRY

Rolla T. Fry, 56, died December 18 after an extended illness. At the time of his death, he was urban traffic engineer for the Kansas State Highway Commission. He was an Associate Member of the Institute of Traffic Engineers.

Mr. Fry was born at Pawnee Rock, Kansas, and attended Sterling College and the University of Colorado. He was employed by the highway department for 27 years, and lived the last 24 years in Topeka.

In addition to his Institute membership, he was a member of the Kansas Engineering Society, the Topeka Engineers Club, and several social and fraternal groups.

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New Publications

The Nation's Highway Program

Chamber of Commerce of the U. S., 1615 H Street NW, Washington 6, D. C. November 1960. 24 pp. $0.50, 1 to 10 copies; reduced price for larger quantities.

The new publication, written for the layman, has a brief analysis of highway legislation and a review of the progress of the 41,000-mile National Interstate and Defense Highway System, the primary and secondary highways and their urban extensions, and the other highway programs receiving federal assistance.

Listing some of the problems confronting the planning, financing, and construction of the broad system of highways, the booklet points out that the chief problem is one of financing. The booklet discusses several alternatives currently proposed for the Highway Trust Fund: (1) increasing highway user taxes to enable the Trust Fund to obtain revenues sufficient to keep the program on schedule; (2) transferring automotive excise taxes now going into the Treasury's general fund to the Highway Trust Fund so that all automotive taxes are used only for highway purposes; (3) considering other financial arrangements such as borrowing from the general fund and bond issues; and (4) curtailing the construction program to fit the revenues anticipated under present legislation.

The booklet reviews the various studies and investigations now underway.

Fundamental Characteristics of Traffic Flow

Adolf D. May Jr. and Frederick A. Wagner Jr. Highway Traffic Safety Center, Michigan State University, East Lansing, Michigan. July 1960. 86 pp. plus bibliography.

The purpose of this research project was to investigate the fundamental characteristics of traffic flow on urban arterial highways, and to determine their inter-relationships, with special consideration given to a determination of the effects of internal friction and of the effects of roadway features as defined by varying degrees of marginal and medial friction.

Seven study locations in urban areas were selected and represent facilities with various combinations of marginal and medial frictions. Each study location had the following similar characteristics: level and tangent roadways, urban environment, heavy traffic volumes, absence of intersectional friction, continuity of amount and type of medial and marginal friction some distance upstream and downstream from study locations, minimum driver visibility of survey equipment, multilaned facilities, and minimum influence due to changing weather conditions.

The specific characteristics and phenomena of traffic operations obtained at the seven study locations that are included in this presentation are:

1. Traffic Volume Characteristics
2. Speed Characteristics
3. Vehicular Headway Characteristics
4. Inter-relationships of the Fundamental Characteristics of Traffic Flow.

Forecasting for Highways: The Record and the Outlook

Bulletin 257, Highway Research Board, 2101 Constitution Avenue, Washington 25, D. C. July 1960. 38 pp. $0.80.

Two papers assessing the methods and techniques of forecasting highway traffic and financing needs to meet the traffic demand are contained in this bulletin. These papers were presented at the 39th Annual Meeting of the Highway Research Board, as follows:

"Need We Fail in Forecasting?" by E. L. Kanwit, C. A. Steele, and T. R. Todd, points out some of the failures in past traffic forecasting and suggests ways of making future forecasts more nearly realistic.

"Outlook for Better Regional and National Forecasts of Highway Traffic and Finance," by Donald E. Church, evaluates briefly procedures in current use in economic forecasting and discusses certain key factors which show promise of improving the techniques of economic forecasting, especially those associated with the prediction of traffic volumes and highway user revenue.

Urban Research — 1960

Bulletin 256, Highway Research Board, 2101 Constitution Avenue, Washington 25, D. C. July 1960. 29 pp. $0.80.

In this bulletin are included the annual Report of Committee on Urban Research and four papers, all as presented at the 39th Annual Meeting of the Highway Research Board. The papers are as follows:

"Research Needs in the Behavioral Sciences Relative to Highway Planning," by Lawrence Krader.

"Open Space Control," by Erling D. Solberg, urges adoption of development rights" by appropriate agencies to protect open spaces against residential, industrial and commercial encroachments so as to provide the areas needed in years to come for future highway rights-of-way.

"Transportation Plans: Washington's Next Steps," by Robert A. Keith, reviews a four-year survey of transportation needs for the Washington, D. C., region and briefly describes the steps

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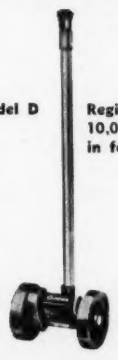

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needed to transform the present planning reports into an ultimately operating transit system.

"Zoning and Traffic Congestion," by W. H. Stanhagen, reviews the direct tie between urban expansion and traffic generation and points out that zoning control of the former can solve many of the future problems of the latter.

Driving Simulators and Application of Electronics to Highways

Bulletin 261, Highway Research Board, 2101 Constitution Avenue, Washington 25, D. C. August 1960. 60 pp. $1.40.

Contained in this bulletin are five papers presented at the 39th Annual Meeting of the Highway Research Board, as follows:

"Driving Simulator Research," by Slade Hulbert and Charles Wojcik, describes two driver testing devices and the results of testing a number of driver subjects.

"Engineering and Psychological Uses of a Driving Simulator," by Bernard H. Fox, outlines some fundamental requirements and uses of driving simulators in traffic safety research.

"Some Technical Considerations in Driving Simulation," by Bernard H. Fox, describes the problems met in the construction and use of a driving simulator.

"Standard Electronic Units Interconnect to Provide Flexible Digital Recording," by Richard C. Hopkins, describes use of standard electronic units in combinations to form flexible digital recording systems for such purposes as recording traffic, weight, speed, deflection, vibration, etc.

"Electronic Highways," by Joseph B. Bidwell, Albert F. Welch, and Eugene A. Hanysz, describes two comparatively simple electronic systems for providing road information and warning drivers of path error.

Highway-Railway Grade Crossing Treatments

By W. A. McLaughlin, Technical Publication No. 13, Canadian Good Roads Association, 270 MacLaren St., Ottawa 4, Canada. October, 1960. 42 pp. plus appendices. $1.00.

The author reports on an extensive survey of the methods which are used in both Canada and the United States to evaluate highway - railway grade crossing treatments. As background for his discussion, he has traced the history of the grade crossing problem including a study of the number of accidents which have occurred. The accident picture is related to both the effectiveness of various devices and the economic considerations.

With the basic tenet that greater degrees of crossing protection should be provided as more economic benefits result, the author describes an approach to an economic analysis. He relates this analysis to a system of priorities. The methods to be used in making the economic analysis are set forth in the appendices.

Metropolitan Transportation

Department of Public Relations, American Automobile Association. 1712 G Street, N.W., Washington 6, D. C. 1960, 31 pp.

One of the features at the recent annual meeting of the AAA was a panel discussion on "The Metropolitan Transportation Problem." Messrs. F. T. Aschman, J. E. Havenner, E. H. Holmes, W. S. Smith and D. C. Wagner were the panelists. Mr. Pyke Johnson served as moderator.

The text of the discussion has been printed in pamphlet form because of the widespread interest in urban transportation. Some of the questions discussed by the group include the health of downtown areas, the urban sprawl, the place of mass transit, and the need for urban freeways. Many of the physical factors involved in a transportation system to serve metropolitan areas are discussed.

Quality of Traffic Flow

By Adolf D. May Jr. and Frederick A. Wagner, Jr. Highway Traffic Safety Center, Michigan State University, East Lansing, Michigan. July, 1960. 105 pp. plus bibliography.

The study described in this publication had three main objectives:

1. Relate roadway features to operating characteristics and accident experience;

2. Formulate mathematical relationships between various vehicle operating characteristics and with accident experience;

3. Develop methods for measuring the quality of traffic flow.

In addition, an effort was made to:

1. Evaluate operating characteristics on the Detroit Expressway system

2. Evaluate operating characteristics on special types of urban arterials

3. Investigate the reliability of the moving vehicle method of estimating traffic volume

4. Apply statistical analyses to travel time studies

5. Make comparative analyses of instrumentation for measuring vehicle operating characteristics.

The work has been written in three parts. Part I deals with the three major objectives, Part II discusses the first two additional objectives, and Part III is concerned with the last three additional objectives.

New Products

Traffic Recorder Show Put 'On The Road'

Fischer & Porter's Traffic Operations Punch (TOP) Recorder is not only new, but it presents an entirely different concept in the recording and processing of traffic flow data. Thus, F&P has been faced with the need to fully explain the TOP system, its operation and its advantages to the various planning, traffic, and purchasing groups who are responsible for the purchase of such equipment. How could this best be accomplished? Company officials agreed upon a mobile unit which would explain the system in its entirety through an actual field demonstration. Now in existence for three months, F&P's road show has already toured 15 states, and according to a representative of the Warminster, Pa. firm "our working exhibit has been enthusiastically received everywhere it has visited."

Two instruments are utilized in the F&P system. The first of these is the TOP portable counter itself which accepts signals from any type of detecting element such as a treadle, pneumatic tube, sonar, radar, or electric-eye. The signal from the sensing element is gathered in the recorder, which accepts up to 20 counts per second; then at 15, 30, or 60 minute intervals,

This traveling demonstration unit tells Fischer & Porter's complete traffic recorder story. The portable counter and translator are shown in the vehicle; the permanent recording unit is in the foreground.

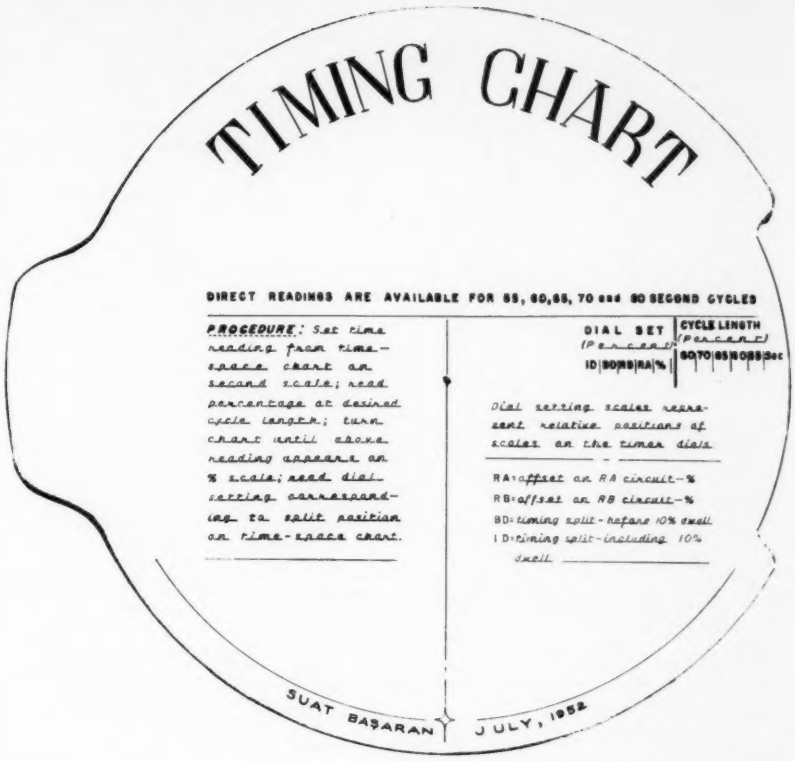
the recorder punches out the cumulative total on tape. The rugged recorder unit is housed in a steel case and is powered by a 7½ volt dry cell battery; a 15-jewel battery-wound spring-operated clock also operates off this battery. The entire package including the battery weighs just 40 pounds and thus the unit is truly portable. A permanent recording unit having its own rectifier is designed for installation in standard traffic enclosures; it will operate on 110-volt a-c power.

The second of the machines shown in the mobile unit is the F&P translator which accepts the punched tape from the recorder and converts it into punched cards or standard computer punched tape. A week's readings taken at hourly intervals can be converted into punched cards or tape in less than one minute. Not only does this reduce the time factor but it eliminates the inevitable errors of manual data handling.

The saving in time and money afforded by the use of this machine data handling system, F&P points out, allows for more extensive surveys and a more accurate analysis with no increase in cost.

The Traffic Operations Punch, Fischer & Porter feels, will supply the answers to complex traffic planning problems by clearly, effectively, and swiftly performing the necessary computations on a mass basis. And like a political candidate, they literally have taken their program to the people . . . the traffic engineering people and their associates . . . who can do something about it.

Arched over a Key West fishing pier, these mercury vapor luminaires came through Hurricane Donna's 70-mile-an-hour winds unscathed. The General Electric M-400 units, designed to withstand 150-mile-an-hour winds, were installed by the City Electric System on the pier, which juts 1,000 feet into the open waters of the Florida Straits. The pier was in the path of Donna, whose smashing sortie through Florida left $200 million in damage.


TIMING CHART
DIRECT READINGS ARE AVAILABLE FOR 55, 60, 65, 70 and 80 SECOND CYCLES
PROCEDURE: Set time reading from time-space chart on second scale; read percentage at desired cycle length; turn chart until above reading appears on % scale; read dial setting corresponding to split position on time-space chart.
DIAL SET (Percent)
CYCLE LENGTH (Percent)
ID BD RB RA %
50 70 65 60 55 Sec
Dial setting scales represent relative positions of scales on the timer dials
RA = offset on RA circuit - %
RB = offset on RB circuit - %
BD = timing split - before 10% dwell
ID = timing split - including 10% dwell
SUAT BASARAN
JULY, 1952

Rotary Signal Timing Chart Developed

A rotary signal timing chart has been developed and put to practical use by Suat Basaran, traffic engineer for the Department of Highways and Traffic, Washington, D. C.

The rotary timing chart is especially designed to give simple, accurate and speedy determination of offset and timer dial settings of the traffic signal controllers. The entire procedure is simplified so that even the percentage values of the time lengths for the different signal indications, in a given time cycle, are indicated on the chart, thus eliminating calculator or slide rule operations. Direct readings are given for 55, 60, 65, 70 and 80 second cycles, and dial setting scales represent the relative positions of the scales on the timer dials.

One of the major advantages is that the rotary timing chart will, almost instantly, indicate the exact position of the offset and the timer dial settings for controllers having a 10% dwell period in every revolution of the dials (i.e., "Trafflex" controllers of the Crouse-Hinds Co.)

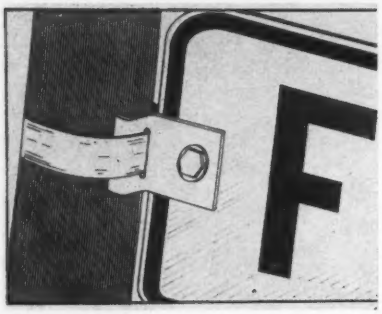
It has proven to be a very valuable time saver. Its fast and easy operation is appreciated by engineers and signal technicians who deal with signal timing. For more details write to Suat Basaran, 2550 N. Greenbrier Street, Arlington 7, Virginia.

New Gerrard Bracket Simplifies Sign Hanging

A new self-locking bracket used to hold two-sided and other cantilever type street signs from round, octagonal and square poles and posts has been introduced by A. J. Gerrard & Company, Des Plaines, Illinois.

Designed for and in conjunction with the City of Newark, the stainless steel bracket locks onto any size wood, metal or plastic post measuring 2" or more in diameter. Each bracket consists of two identical parts that are bolted together holding the sign in between. The entire unit is then strapped to the post with stainless steel strapping. As the tension on the strap is increased, the bracket legs become locked in position on the post. The increased tension on the bracket also tends to hold the sign more firmly. However, the signs can be removed and replaced without taking off the strapping or bracket.

The new brackets result in sizable savings over other methods of installing signs. Since double faced signs



can be used with the new bracket, the need for two individual signs bolted back to back is eliminated. The new method allows the bracket to be bolted to the sign in the shop. The actual hanging of the sign on the post then takes only a matter of seconds.

Illustrated literature on the brackets and other sign hanging equipment currently in use by over 1000 state and municipal governments is available from A. J. Gerrard & Company, 400 East Touhy Avenue, Des Plaines, Illinois.

Revere Introduces Photoelectric Control

New photoelectric light controls by Revere Electric Mfg. Co. are light-sensitive switches which automatically turn on outdoor lighting installations such as street lights and service station lights at predetermined levels of darkness and turn them off when they are no longer needed. Series 4005 is the basic control; 4006 series controls are equipped with an electric timer to preset any desired "off" period and temporarily override the photoelectric cell.

The control consists of a cadmium sulphide photoelectric cell with a high dark resistance of + 5 megohms, which can operate continuously carrying 500 milliwatts of power. It also features a hermetically sealed tungsten-mercury solenoid type switch with a load capacity of 20 to 30 amperes at 120 volts or 240 volts AC and an in-rush current capacity of 130 amperes. An air gap lightning arrester rated at 1000 volts rms with a critical spark-over at 2400 volts is built into each control. The light level setting is adjustable from ½ to 4 footcandles. Normal factory setting is 2 footcandles.

Encased in a weatherproof, shock resistant butyrate housing, the control operates through a temperature range from —40 F. to 165 F. It is available with either a standard 3-prong locking type plug which meets EEI-NEMA

specifications and carries a 15 ampere load, or with color coded 14″ pigtail leads which will carry the full 30 ampere current capacity of the mercury switch. The units are available with optional 2″ slipfitter or mounting brackets.

Descriptive literature may be had by writing to: Revere Electric Mfg. Co., 7420 Lehigh Ave., Chicago 48, Illinois.

Henberger Co. Expands To Los Angeles

The John C. Henberger Co., manufacturer's representative, with its principal office in San Diego, has opened a branch office in Los Angeles.

The new office, located at 11022 North Haskell Avenue, Grenada Hills, California, will be run by Richard Wald, formerly district sales manager for a major manufacturer, and well-known to many in the traffic engineering field.

This represents a large advance for the Henberger Company, which started operations in San Diego two years ago. The owner, John Henberger, was for a number of years associated with another major manufacturer, and is himself well-known to the traffic field not only in California but in many other parts of the country.

Radio Traffic Control Units Expand System

The Wayne County Road Commission has announced expansion of its radio traffic control system. Twenty Motorola receiver-decoders are being installed in the Detroit area to bring traffic signals at 50 intersections under radio control. The Wayne County system, which went on the air in April, 1958, is both the country's first 960-megacycle radio traffic control network and Motorola's initial installation in the field.

New Lane Markers Now Available

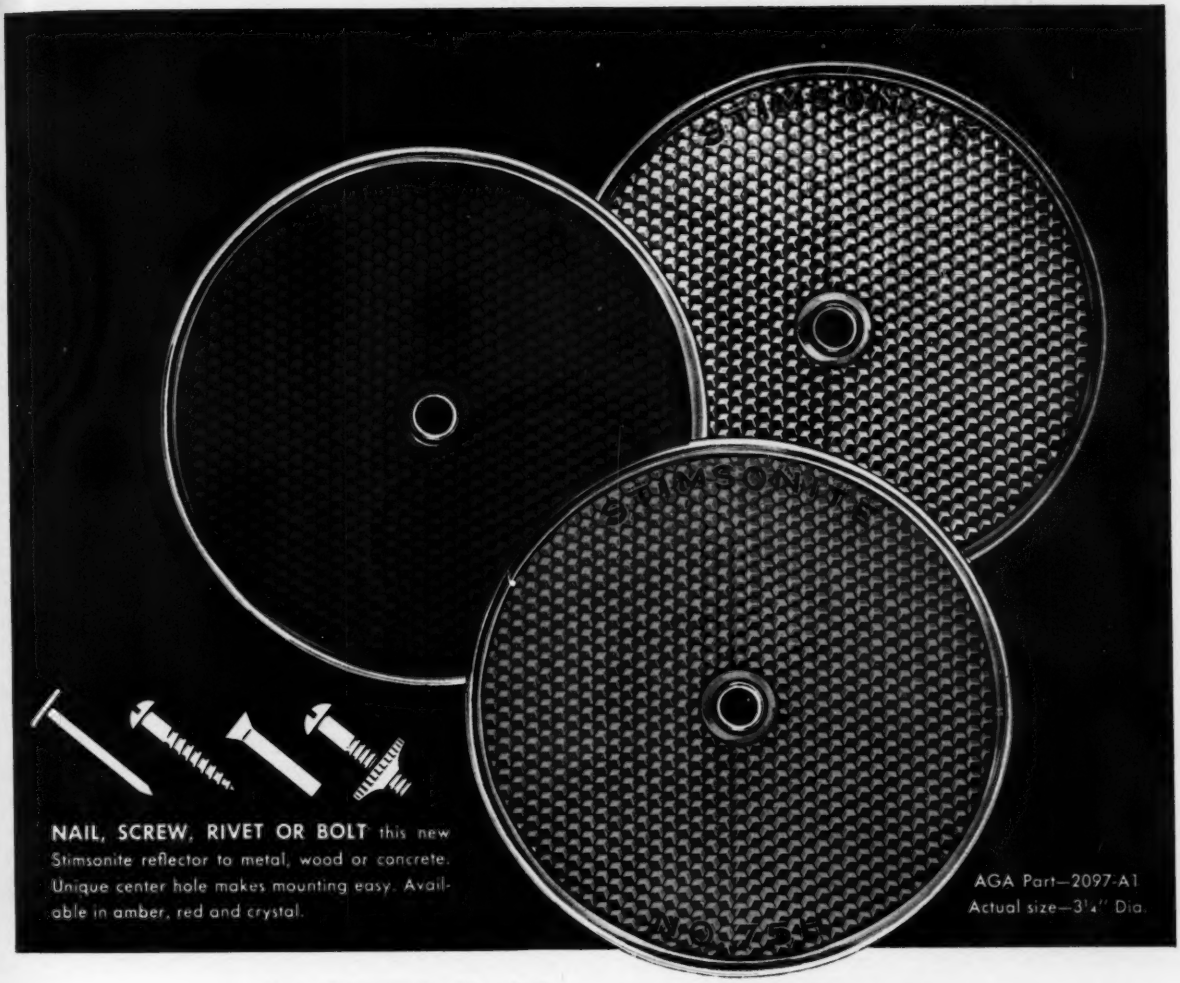
A highly effective, new traffic lane marking system providing exceptional nighttime and bad weather visibility has been developed and is being manufactured by the Adhesive, Resin and Chemical Division of the American-Marietta Company.

New Lite-Lane traffic guide systems are available as a complete package including highly reflective, contoured markers, a high strength epoxy type adhesive for marker-to-pavement bonding, and an efficient semi-automatic application system which is said to insure maximum in-place life and greatest economy.

Tests indicate that a useful life of 7 to 10 years may be expected from the Lite-Lane markers under extreme traffic conditions. The marker is a low-profile durable plastic disc with unusual impact resistance and flexibility when bonded to the roadway. It contains a uniform dispersion of reflective glass beads throughout which provides exceptional brilliance when exposed to vehicle lights. Because of its consistent composition, the marker remains highly reflective throughout its entire life. As the grinding action of tires wears it down, new beads continually are exposed to maintain original reflectivity year after year.

When compared with conventional paint stripes heavily loaded with glass beads, Lite-Lane markers were found to remain brightly visible while stripes disappeared under fog or wet road conditions, according to the manufacturer.

To provide the strongest possible bond between the marker and the pavement, American-Marietta research and engineering staffs developed an epoxy type adhesive. Noted for its ability to stick anything to anything, the epoxy



NAIL, SCREW, RIVET OR BOLT this new Stimsonite reflector to metal, wood or concrete. Unique center hole makes mounting easy. Available in amber, red and crystal.

AGA Part—2097-A1
Actual size—3¼" Dia.

NEW! STIMSONITE CENTER MOUNT REFLECTOR

The new Stimsonite reflector has a unique advantage permitting fast, easy mounting. You can use a screw, bolt, nail or rivet to mount this versatile new product on metal, wood or concrete.

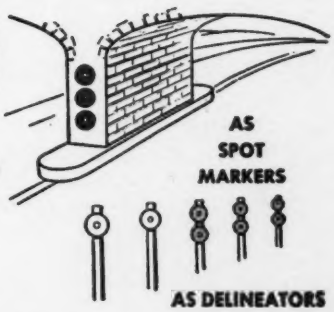
OTHER BIG ADVANTAGES:

Long range visibility—returns more light to source than any other reflector.

Hermetically sealed and housed in sturdy aluminum.

Noncorrosive and weatherproof.

Write today for bulletin with full details.



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ESNA

STIMSONITE SIGNAL DEVICES (AGA 1909 1959)
ELASTIC STOP NUT CORPORATION OF AMERICA
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On dry road surfaces Lite-Lane Traffic Guide Markers show the same reflective brilliance as heavily glass-beaded painted stripes applied with conventional striping equipment. (Unretouched driver's-eye view—highbeam).

When conventional stripes vanish under hazardous wet road conditions, Lite-Lane offers a clearly visible path of light to safely guide the nighttime motorist. (Unretouched photograph-high beam).

as utilized by A-M researchers offered a tough and durable bonding agent with a shear strength exceeding the cohesive strength of the strongest concrete. The adhesive, when used with catalyst and heat cured with Lite-Lane application equipment, enables the markers to be installed quickly and without halting traffic flow for extended periods.

Aside from closing only a fraction of the roadway required for painting conventional traffic stripes, installation of Lite-Lane markers with the semi-automatic system allows application during variable weather conditions. Because all the components are designed for environmental tolerance, the markers may be installed on wet or dry pavement or over traffic lines without surface preparation. The markers also may be applied at temperatures varying from 38°F. to 90°F., and over abraded surfaces, with or without preheating.

A safety feature of the markers is that they audibly signal a careless or drowsy driver that he has wandered out of his lane or to the edge of the road. Because of the low-profile design there is no impact hazard endangering vehicle control.

Specifications and detailed information are available on request from American - Marietta Company, 3400 13th Avenue S.W., Seattle 4, Washington.

Technical Notes

THE PROFESSIONAL RESPONSIBILITY OF CITY PLANNERS AND TRAFFIC ENGINEERS IN URBAN TRANSPORTATION

This statement covers those phases of urban transportation in which the city planner and traffic engineer have common interests such as, highways, transit, and terminal facilities and services. It recommends the establishment of certain interprofessional relationships that normally should be followed to foster sound community development and insure safe and efficient transportation service.

The governing bodies of the American Institute of Planners and the Institute of Traffic Engineers have adopted this as their interprofessional policy statement.

CLOSE COOPERATION of various professional groups is indispensable in any urban transportation program. This applies particularly to the city planner and the traffic engineer. Others who are directly concerned are the public works director, city engineer, police official, transit official, utility manager, as well as county, state and Federal highway officials. All must participate since urban transportation has so many facets—planning, design, construction, operation and maintenance.

To the extent possible, members of these different groups must perform as a team. Obviously it must be recognized that each member has certain individual assignments to carry out either by law or administrative order. Generally speaking, however, there is still ample latitude for the cooperative effort that is needed.

For his part, the city planner is assigned the responsibility of developing and guiding the implementation of the comprehensive community plan. Transportation is one of the most important elements in such a plan. Therefore, the city planner, of necessity, must see that transportation facilities are integrated with other key elements of the community plan. This, of course, can be achieved only by coordinating his efforts with those of other professionals who are responsible for building and operating these facilities. The city planner must weigh with the other groups the interrelationship between various elements of the comprehensive plan.

The traffic engineer's responsibility is to see that the transportation system in a community is operated safely and efficiently. In this task he is interested in the planning and designing of the transportation facilities as they will ultimately affect the operation of the system. He is also interested in the operational control measures such as traffic signals, signs and markings, as well as the necessary laws regulating traffic required for safety and efficiency. In fact, he is concerned with any plans that will affect desires and needs relating to the movement of people and goods.

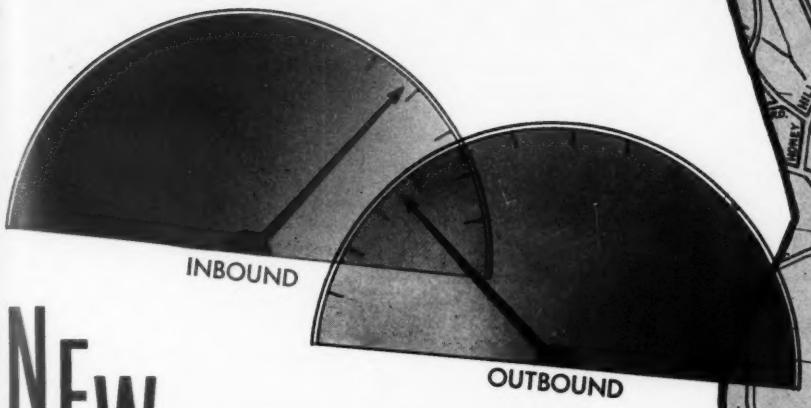
The goal of both city planners and traffic engineers should be the development of a unified transportation program that effectively fosters sound community development and assures safe and efficient transportation services.

DIVISION OF RESPONSIBILITY

The following outline indicates the general responsibility of the city planner and traffic engineer in various phases of the transportation program. In carrying out these responsibilities, the type of cooperation will naturally depend upon the status of transportation and other community plans. While the transportation plan and land use plan are under development, cities will undoubtedly move ahead with various types of projects which will call for collective action. In this event it is essential that the city planners and traffic engineer get together as early as possible in the development of sound projects.

In communities where a definite transportation plan exists, much of the cooperative effort and individual action will, of course, be directed to carrying out the plan and keeping it up to date and, therefore, will be concerned mainly with the last portion of the outline.

But, regardless of the status of transportation plans in an area, there

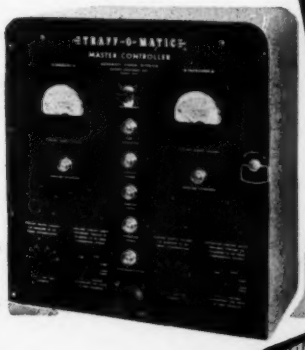


NEW TM SYSTEM

provides traffic-actuated signal control for arterial flow . . . automatically . . . for less money

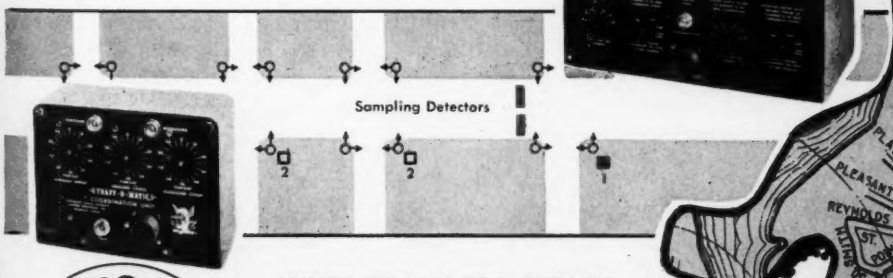
The TRAFF-O-MATIC® TM SYSTEM is a traffic-actuated, 3-offset, 3-cycle length system that provides a low cost method of arterial signal control. It responds to *actual* traffic changes *without time clocks . . . . . without program drums.*

Continuously and automatically the TM System seeks and selects the most favorable offset and cycle length combination based on the relative volume levels of two sampled directions of traffic flow. Operating adjustments are made without tools. Circuitry and component construction incorporate the latest design techniques for maximum service and ease of maintenance.



1 ■ **TRAFF-O-MATIC MASTER MODEL TM-1 maintains continuous inbound-outbound volume comparison . . . automatically selects one of three offsets to best serve traffic flow, in addition to free operation at low volumes.**

2 □ **TRAFF-O-MATIC COORDINATING UNIT MODEL TM-21, one with each local semi-actuated controller, interprets Master's offset instructions . . . easy knob adjustment of three offsets . . . each offset can be assigned an individual background cycle length.**



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AUTOMATIC SIGNAL DIVISION

EASTERN INDUSTRIES, INCORPORATED
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ELECTRO-MATIC® CONTROL
TRAFFIC ACTUATED

are many routine chores that the city planner and traffic engineer must tackle cooperatively. The city planner in reviewing site plans for major developments, or proposed major changes in zoning densities, should discuss such matters with the traffic engineer. The traffic engineer should review with the city planner major operational changes such as one-way streets. On all daily administrative matters that impinge on one another's work, a sincere effort must be made to "work with" all interested parties.

GATHERING THE FACTS

Basic to any sound transportation plan is a continuing fact-gathering program. This above all requires cooperative action. For this reason the National Committee on Urban Transportation recommends that a technical coordinating committee be established. This should include the city planner and traffic engineer as well as the public works director, the city engineer, transit and highway officials. The committee would guide the general collection of facts and development of the transportation plan and program.

The impetus for the establishment of such a program should come from the various professional groups involved, though the leadership should rest with the top administrative official. Usually this type of program can be carried out within the existing administrative structure. However, at times it may be advantageous to create a special technical team or staff to help carry out the work load and assist the technical coordinating committee. This type of coordinated approach should also be established on a regional basis.

With such a committee framework, the responsibilities of the city planner and traffic engineer generally should follow the pattern below. In some instances the joint responsibilities may involve only advisory duties; in others, actual participation in the work.

Joint Responsibility:

1. Street use study
2. Origin and destination study (often conducted by state highway departments)
3. Study of transportation expenditures
4. Use of transit (if not undertaken by the transit agency)

City Planner's Responsibility:

1. Land use survey
2. Economic base studies
3. Population surveys (zone by zone)
4. Employment surveys (zone by zone)
5. Social and economic surveys

Traffic Engineer's Responsibility:

1. Traffic volume surveys
2. Travel time studies
3. Accident studies
4. Street capacity studies
5. Parking studies
6. Control devices surveys

ANALYSIS OF THE FACTS

The analysis of the data collected will be largely the responsibility of the professional groups that have assembled the information. However, collation of the facts and their evaluation should be a joint effort. Mutual understanding of how the facts are interrelated is most important in the development of an effective transportation plan and program.

Joint Responsibility:

1. Determination of relationships between land use, transportation facilities and travel habits
2. Analysis of the street patterns—spacing, intersection frequency, traffic volume and land use type
3. Review of the traffic and transit service characteristics
4. Analysis of land access problems as related to types of streets

City Planner's Responsibility:

1. Evaluation of residential land patterns
2. Evaluation of commercial and industrial patterns
3. Location study of parks, schools and other public facilities
4. Analysis of social and economic patterns

Traffic Engineer's Responsibility:

1. Comparison of existing volumes and street capacity
2. Comparison of travel times on various street segments
3. Comparison of accident patterns for various street segments
4. Analysis of traffic control measures

The analysis of these facts should be used in developing projections of future land and traffic patterns. This will call for a joint decision as to how this can best be done for a particular community. Once this is achieved, the nature of the traffic problem should be evaluated by all professional groups associated with carrying out the transportation plan.

DEVELOPING THE PLAN

When the facts have been collected and analyzed, appropriate standards and objectives should be adopted to guide the development of the plan and to measure transportation and terminal deficiencies, present and future. Much of this work will have to be done on a cooperative basis, by professional groups concerned, though a considerable amount of detail work can be left to staff.

Joint Responsibility:

1. Establishment of general objectives relating to community development
2. Adoption of standards for transportation — design capacities, cross sections, access controls, spacing and intersection frequency, speed etc.
3. Determination of transportation and terminal deficiencies
4. Formulation of alternative solutions that should be considered

City Planner's Responsibility:

1. Review of land use and density patterns to help formulate overall objectives as to the development and redevelopment of the community
2. Consideration of the different land use and density alternatives that could be realized by the community
3. Assessment of the effect that various transportation plans would have on land development
4. Coordination of the transportation plan with all other elements of the general plan

Traffic Engineer's Responsibility:

1. Review of existing level of transportation services as a means of determining appropriate standards
2. Testing the various transportation alternatives including assignment of traffic to the various proposed systems
3. Determination of the several types and location of transportation facilities with regard to operational aspects

Following the testing of adequacy

of the alternative proposals, an evaluation of each proposal should be made. Yardsticks can be established to measure the benefits to the traveling public as well as the impact that each plan will have on community development. Having evaluated each proposal on the basis of these findings, the technical coordinating committee can now recommend which plan is most appropriate for the community. Generally local law will require that the plan be evaluated and then adopted by the local planning agency. The necessary approval of the State Highway Department should also be sought.

CARRYING OUT THE PLAN

In carrying out the plan, a close working relationship between the various professional groups can help to insure the logical development of the transportation program, while at the same time minimizing disruption of normal community activities. Such a team is especially important with regard to design details that affect operation and community amenities.

Division of responsibility at this stage would be as follows:

Joint Responsibility:

1. Determining the exact location of proposed transportation facilities
2. Establishing transportation improvement priorities
3. Keeping the data and plans up to date

City Planner's Responsibility:

1. Establishing the necessary planning program (off-street parking and load requirements in zoning ordinances, requirements that subdivisions conform to the transportation plan, etc.) to foster the development of the transportation plan.
2. Consulting with the traffic engineer to report on the impact that various zoning changes will have on transportation problems

Traffic Engineer's Responsibility:

1. Establishing the necessary operational and control measures to assure smooth traffic operation during construction of facilities
2. Determination of operational measures necessary to effectuate the transportation proposals
3. Review with the city planner proposed major traffic operational changes like one-way street and thru-street program

In developing and implementing the plan, all professional groups have a responsibility to inform the public fully of their actions. Public support for any transportation program is most essential, and this fact must be recognized during all phases of the program.

Prepared by a joint committee of AIP and ITE, with the following membership:

Alan M. Voorhees, Chairman (AIP, ITE)
Leon W. Corder (ITE)
Roger L. Creighton (AIP)
Philip E. Geissal (AIP)
Lawrence Livingston, Jr. (AIP)
William R. Marston (ITE)
Frederick A. McLaughlin, Jr. (AIP)
O. K. Normann (ITE)
Richard A. Overmyer (ITE)
Arthur T. Row, Jr. (AIP)
Ross T. Shoaf (ITE)

Technical Council News

Research and the ITE

As part of the program of the Technical Development and Research Fund of the Institute of Traffic Engineers, a questionnaire was distributed several months ago by the members of the Technical Council to their standing committees and project committee chairman. The objective of the survey was to identify specific projects or areas of research which the Institute should encourage. The results, it was felt, would be valuable to the Department Heads in planning the work of their individual Departments. However, of more immediate importance, the results will help the Review Committee of the TD&R Fund to determine research priorities.

Every practicing traffic engineer probably has his own ideas about the areas in which research is needed. The respondents to the questionnaire felt strongly that additional study is needed on warrants for traffic controls and regulations, as well as on the design and location of devices. In this same area, returns indicated the need relating operating characteristics to controls and a corresponding need to develop information on controls which laymen can assimilate and accept.

Integration of transportation in urban areas was also considered important, together with related problems of mass transit, city planning, and land use. In the specific field of highway transportation, better information on tax losses, land losses, maintenance costs, and accident savings is needed to evaluate fully the economics of freeways. There are still questions about interchange design in urban areas, including the degree of control that can or should be exercised over entrance ramps.

In the field of accidents, much more information is needed on the matter of relating design features to accidents. Studies are also needed to determine drivers' reactions to various stimuli—projects which suggest the need for an overall analysis of driver behavior.

These ideas are but some indication of the research needed in the field of traffic engineering. Anyone who has an interest in research and the facilities to carry on some of this work is invited to submit a proposal for a project which needs funding. The Review Committee of the TD&R Fund has developed a form of request for this purpose, which is shown below.

INSTITUTE OF TRAFFIC ENGINEERS

Technical Development and Research Fund

Form of Request for Financial Aid

The following is an outline of the information which should be set forth briefly, but clearly, for each project for which aid is desired.

I. Description of Project and Objectives
   - A. Project Description
     - (1) Concise description of recommended project
   - B. Project Objectives
     - (1) Objectives to be obtained
   - C. Project Justification or Desirability
     - (1) Reasons why project is desirable
     - (2) Value to profession
     - (3) Present status
   - D. Responsibility for Project
     - (1) Individual or agency responsible for the project

(2) Other agencies who may participate

II. Procedures

A. Bibliography

B. Step-by-Step procedures required

C. Anticipated means of publication

III. Project Schedule and Cost

A. Project Schedule

(1) How soon can project be started if funds are authorized

(2) Estimated time for completion

(3) If project can be undertaken in stages, set forth sequence of stages and estimated time required for each

B. Project Cost

(1) Set forth estimated requirements for:

(a) Salaries and wages

(b) Expendable supplies

(c) Equipment

(d) Travel Expense

(e) Publication costs

(f) Other direct costs

C. Stage Costs

(1) If project can be undertaken in stages (III-A-3), set forth total estimated cost of each stage.

IV. Facilities Available

A. Existing facilities that can be utilized for project

(1) Physical Facilities

(2) Libraries

(3) Equipment

V. Other Resources Available

A. Other funds and resources available for project

Name of Agency Making Request

By

Date

As described in the December issue of TRAFFIC ENGINEERING, these proposals will be studied by the Review Committee and each will be evaluated in terms of the proposed project's value to the traffic engineering profession and the need for research in that particular area.

Others may be acutely aware of definite needs in the field, but may not wish to submit proposals because of a lack of talent or the facilities for research. Such individuals can perform a valuable service by forwarding their ideas either to the Department Head most likely to be concerned or to ITE headquarters to the attention of the Staff Engineer, Stephen G. Petersen, so that he may place the ideas in the proper channels.

CROSSOVERS

(Continued from page 16)

3. Removal of all unnecessary crossovers.

4. Relocations or removal of all crossovers too close to signals.

5. Removal, wherever possible, of all neon lights which distract from a crossover and cause unsafe operation.

6. Plastic material should be used for year round pavement marking.

7. Continued study of improvement to overhead light.

8. Extension of no stopping regulation to more than 30 feet, where needed.

9. It should be noted that large signs have been erected at all highway entrances to the Metropolitan area, warning out-of-towners to watch for and obey pedestrian crossover signs.

Summary

The pedestrian crossover was conceived as a traffic control device which would afford pedestrians a means of crossing busy traffic arteries, and at the same time create as little delay as possible to vehicular traffic. In the more than two years of its operation, the pedestrian crossover has proved a success in fulfilling its original purpose.

The number of requests for the installation of traffic signals has dropped markedly, while numerous requests are being received for additional crossovers. Warrants as to need and suitability of location are being worked out to ensure that the program is not overdone.

With continued publicity, education and enforcement, combined with more widespread use, there is no reason why the pedestrian crossover should not be an unqualified success.

Coming Events

February 28-March 2—ILLINOIS HIGHWAY ENGINEERING CONFERENCE
Contact: John W. Hutchinson, 304 Civil Engineering Hall, Urbana, Illinois.

March 2-3—ILLINOIS TRAFFIC ENGINEERING CONFERENCE
Contact: John E. Baerwald, 404 Civil Engineering Hall, Urbana, Illinois.

March 5-7—SOUTHERN SAFETY CONFERENCE—
Annual Conference and Exposition, Atlanta Biltmore Hotel, Atlanta, Georgia. Contact: W. L. Groth, P. O. Box 8927, Richmond 25, Va.

March 6-24—TRAFFIC ENGINEERING SEMINAR—
Three-week course sponsored by Midwest Section, ITE and Northwestern University. Tuition $195. Contact: The Traffic Institute, 1804 Hinman Ave., Evanston, Ill.

March 28-30—WESTERN SAFETY CONGRESS—
8th Annual Congress & Exhibits, Ambassador Hotel, Los Angeles, Calif. Contact: Greater L. A. Chapter NSC, 3388 W. 8th St., Los Angeles 5, Calif.

May 18-19—GEORGIA TECH CONFERENCE ON PARKING—
Contact: Director of Short Courses and Conferences, Georgia Tech, Atlanta 13, Ga.

August 21-26—WORLD TRAFFIC ENGINEERING CONFERENCE—
31st Annual Meeting, Institute of Traffic Engineers and 6th International Study Week in Traffic Engineering, Sheraton-Park Hotel, Washington, D. C. Contact: ITE, 2029 K St. N.W., Washington 6, D. C.

DISTRIBUTION FORECASTS

(Continued from page 29)

ration of work trips into several classifications by major occupation or income groups, or into at least "blue collar" and "white collar" classifications. Past experience has demonstrated the dangers of attempting to divide total trip volumes into too many categories to which separate diversion curves and measurements would be applied. What is here suggested is that, with further analysis and research, the separate trip categories might be further divided and then selectively regrouped to give more accurate bases for diversion curve formulation and trip distribution forecasts.

It is to be hoped that transportation and traffic engineers, faced with the problem of making such modal traffic distribution forecasts, will fully utilize their available resources and exercise ingenuity and effort towards further

Your actuated controller is as good as its detector, specify the best . . .

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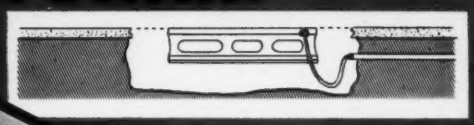

Model 242 Surface-Mounted Magnetic Detector

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research in this increasingly important area of traffic engineering.

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3. Technical Report on Rapid Transit Traffic for the San Francisco Bay Area Rapid Transit System, H. D. Quinby, Parsons, Brinckerhoff, Hall and Macdonald, January, 1956.
4. Highway Traffic Estimation, Eno Foundation, 1956: Chapter 4.
5. Southern New Jersey Mass Transportation Survey, Parsons, Brinckerhoff, Hall and Macdonald, 1956 (esp. pages 33-41).
6. Highway Research Board Bulletin 119, 1956 (esp. pages 1-16 and 17-38).
7. Transportation Usage Study, Cook County Department of Highways, Chicago, Illinois, December, 1957.
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11. Chicago Area Transportation Study, Report Volume II (1960), and various technical monographs (1956-1960).

Letter to the Editor

Trenton 8, N. J.
December 14, 1960

Dear Sir:

I wish to add my congratulations to Mr. Charles Pinnell's receipt of the 1960 Past President's Award for his very fine paper entitled "Driver Requirements in Freeway Entrance Ramp Design."

He has brought out very succinctly many points which seemingly have been much too long in the making in spite of the fact that many of these features were incorporated in the designs of the Pennsylvania Turnpike and the New Jersey Turnpike by Charles M. Noble.

In passing, I would like to reemphasize the importance of the use of a very flat angle of entrance combined with adequate visibility. In this connection, greater visibility could be provided by elevating the curved portion of the ramp roadway so that it would be higher than the main roadway. This higher elevation provides another advantage in that it enables ramp vehicles to get up to freeway speed much easier or unconsciously helps the ramp driver to enter at higher speed which Mr. Pinnell's studies show are safer, although contrary to much past thinking.

In connection with the point that a single lane ramp is more efficient until freeway capacity is reached, may I suggest that some form of actuated signal equipment be used to prevent ramp traffic entering the freeway if it is running at capacity. Vehicle detection could be placed in the right hand lane of the freeway a sufficient distance prior to the ramp to permit a stopped ramp motorist to get his vehicle up to speed to enter the gap that the detection would indicate would be arriving in "X" seconds. In other words, ramp traffic would be controlled by a traffic signal which could display either flashing amber or flashing green when traffic volumes on the freeway are light enough to permit ramp traffic to enter. Whenever freeway traffic is too heavy to permit efficient entry by ramp traffic then the signal would display a steady red. In this way the efficiency and safety of the freeway would be maintained while at the same time indicating to some extent to motorists about to enter the ramp that it might be advantageous for them to use another facility.

May I suggest that basically the same acceleration lane shape be used for deceleration lanes to get away from two undesirable features of present design, one of those being the considerable deceleration motorists are now doing in the normal right hand through lane of the freeway. This deceleration causes sudden slowing or lane changing by through traffic which not only reduces the capacity but also the safety. The other point is that with many present designs it is much easier to leave the freeway by keeping as far to the left as possible prior to turning to the right and then to follow a long sweeping curved path into the ramp. If a short length of tangent (100-200') were used between the Vee of the nose and the P.C. of the ramp curve, this unsafe practice would be largely eliminated and greater use of the deceleration lane would result. In other words, the correct and safe path would be the easy thing to do and it would be forced on those motorists who might not normally comply with safe driving practices. This short length of tangent could be considered part of the length needed for deceleration purposes although it might be more desirable to add it to the calculated length of deceleration as a safety factor for those motorists who may misjudge their speed as they approach the ramp curve.

Some very excellent points along these lines are made in a new publication entitled "Report By The Special Freeway Study and Analysis Committee to The Executive Committee of The American Association of State Highway Officials" February 1960.

Herbert J. Klar, P. E.

Section News

CANADIAN SECTION

The Canadian Good Roads Association held its Annual Convention in Toronto recently and members of the I.T.E. played a very active part in the convention proceedings. New committee chairmen and officers were also appointed and positions held by I.T.E. members are indicative of the prominent part they played:

(a) The Joint Committee on Uniform Traffic Control Devices which was set up by the Canadian Section of the I.T.E. and the C.G.R.A. has been reconstituted as the Traffic Control Devices Committee of the C.G.R.A. It was this Joint Committee which was responsible for the preparation of the Manual on Uniform Traffic Control Devices. The new committee was formed to keep the manual up to date. The chairman of this Committee is W. H. Finnbogason, Traffic Engineer of Winnipeg with J. H. Harding, Traffic Engineer for the British Columbia Department of Highways as Vice-Chairman. Two of the three sub-committees also have I.T.E. members as officers as follows:

Technical and Research Sub-Committee:

Chairman — Jacques Barriere, Asst. Traffic Engineer, Montreal.

Secretary—J. L. Forster, Traffic Control Engineer, Ontario Department of Highways.

Editing and Publication Sub-Committee:

Chairman—M. T. M. Nielsen, Traffic Engineer, Ottawa.

(b) Some of the other C.G.R.A. Committees with Canadian I.T.E. members as officers are:

Scholarship Awards Committee:

Chairman—H.M. Edwards, Queens University, Kingston, Ontario.

Economics, Finance & Administration Committee:

Secretary—P. E. Wade, Ontario Department of Highways.

Planning and Design Committee:

Chairman—W. J. Malone, Deleuw Cather & Co., Toronto.

Traffic and Operations Committee:

Chairman—H. F. Burns, A. D. Margison and Associates Limited, Toronto, Ontario.

Vice Chairman—W. Q. Macnee, Ontario Department of Highways.

Secretary—E. F. Gillies, Minnesota Mining and Manufacturing Co., London, Ontario.

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Rising costs were plaguing Green Bay, Wisconsin's street name sign system. Then Director of Public Works Francis J. Euclide talked it over with 3M. "When I had the facts," he recalls...

"I SAW HOW 'SCOTCHLITE' SHEETING WOULD SAVE MONEY FOR GREEN BAY"

When reconditioning street name signs begins to cost more than buying new ones, something must be wrong. So thought Director of Public Works Francis J. Euclide of Green Bay, Wisconsin, about three years ago.

"I remember the day," he says, "that I discussed our problem with the 3M salesman. He gave me the costs of a different system: making and maintaining all our signs with 'Scotchlite' Reflective Sheeting. I checked his figures against my own costs. It was obvious. In the long run 'Scotchlite' Sheeting would save money for Green Bay."

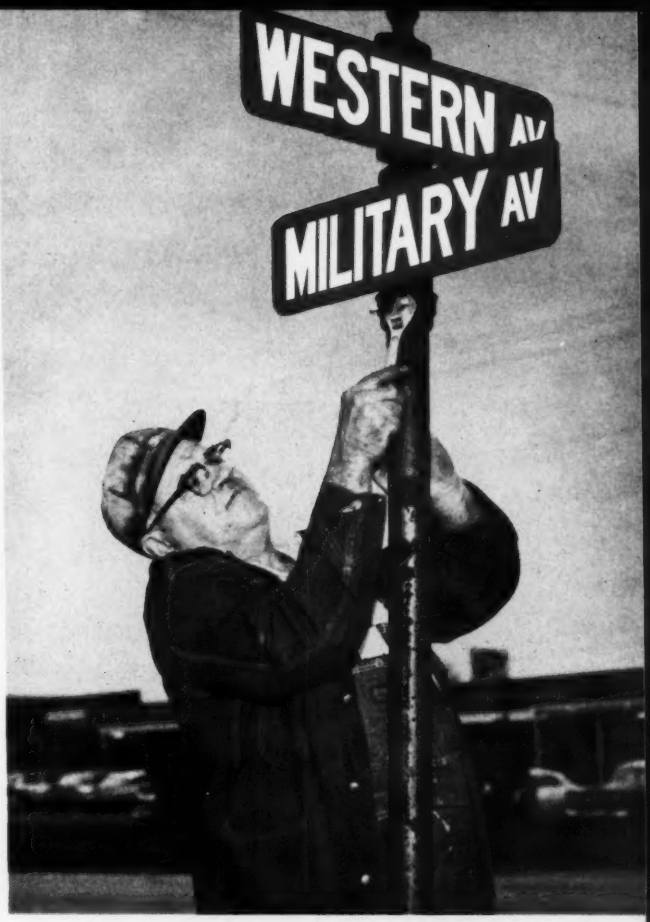
And so it has. A one-man shop, centered around a "Scotchlite" Vacuum Applicator that bonds reflective sheeting to aluminum blanks, turns out low cost, first quality signs as quickly as they are needed. No more waiting weeks, even months, for sign delivery.

Maintenance is simplified and less expensive, too. The aluminum is easily reclaimed, requires no priming, and can be quickly refaced with pre-cut reflective letters and backgrounds.

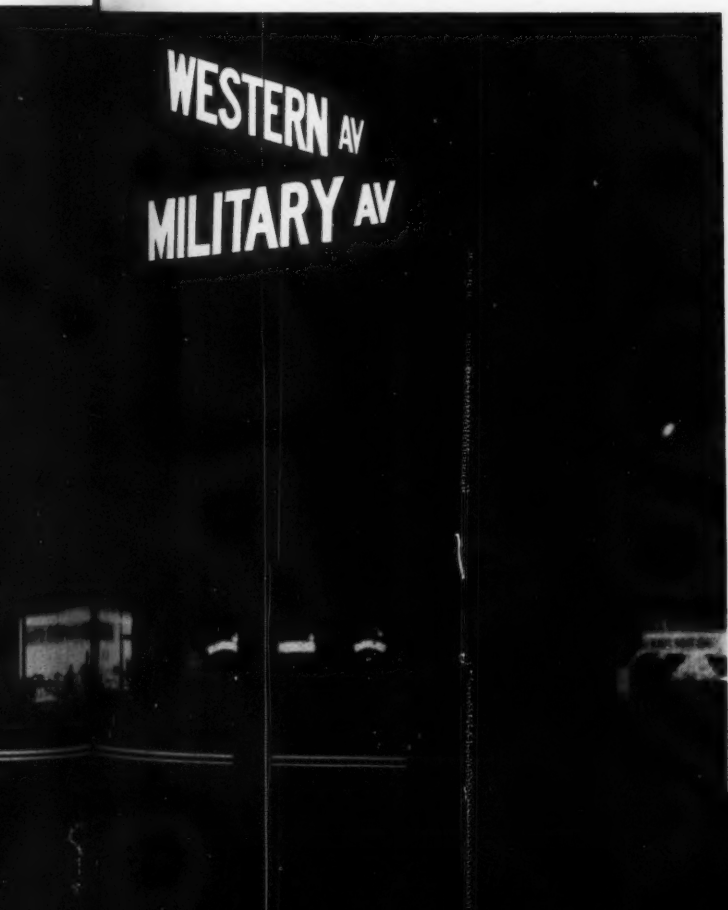
While sign costs dropped in Green Bay, sign performance immediately went up. For street name signs of "Scotchlite" Sheeting are brightly visible, clearly readable in headlight beams. They never leave motorists in the dark.

Have *you* looked at your street name sign system lately?

HIGH COST OF MAINTENANCE on signs like this led Green Bay to switch to "Scotchlite" Sheeting. It used to take six men all winter to respray the old backgrounds and letter new legends by hand. If signs were bent, they chipped, rusted, and had to be thrown out.



REPLACEMENT WITH "SCOTCHLITE" Sheeting, applied to aluminum panels, has proved to be a money-saver. Today one man in the Street Dept., Charles Lauscher (right), makes and maintains all signs for an entire city of 63,000 people. If these chip-resistant, rust-proof signs are ever bent, they are easily straightened and returned to duty.



KEY TO FAST SERVICE in Green Bay's new signing system is the "Scotchlite" 3′ x 4′ Vacuum Applicator. "Before," Mr. Lauscher says, "it sometimes took two months to get a replacement sign. Now, if a home owner complains about a sign that has been vandalized, I can bring it in, apply a new face in the applicator if necessary, and have it back on the job—all within an hour or two."

SPECIAL SAVINGS! Save up to 10% on street name sign materials. Save $51.00 on the "Economist" Applicator. Offer expires March 31, 1961. See your 3M Representative or write Dept. RBI-21, 3M Co., St. Paul 6, Minn.

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MEMBERSHIP APPLICATIONS

The Institute of Traffic Engineers welcomes applications from qualified traffic engineers, but does not desire as members persons who are unqualified. Listed below are the names of those from whom applications for membership or transfer in grade have been received since the last published list. Institute members are urged to review this as soon as possible and immediately inform the Executive Secretary's office if names of people are found who are known to be unqualified for ITE membership or transfer.

New Applications

BARRETT, Theodore Harvey
Associate Professor—Civil Engineering Department, Michigan College of Mining & Technology, Houghton, Michigan for ASSOCIATE.

BESSELAAR, Oswald Hubert
Highway Designer—Idaho Department of Highways, Traffic Section, Boise, Idaho—for JUNIOR.

BRAND, Daniel
Research Assistant (Graduate Student)—Massachusetts Institute of Technology, Cambridge 39, Mass.—for JUNIOR.

BURKS, James W., Jr.
Senior Traffic Engineer—Texas Highway Department, Beaumont, Texas—for ASSOCIATE.

BURNINGHAM, Bryant Dale
Chief Research Engineer—Utah State Department of Highways, Research Section, Salt Lake City, Utah—for ASSOCIATE.

CAMPBELL, Lowell Raymond
Acting Assistant Traffic Engineer—City Engineering Department, Winnipeg, Manitoba, Canada—for JUNIOR.

CHARLAND, Joseph Louis Jacques
Traffic Engineer—Quebec Roads Department, Quebec, P. Q., Canada—for JUNIOR.

CLARK, John William
Rural Traffic Engineering Studies Specialist—Ohio Department of Highways, Bureau of Traffic, Columbus 15, Ohio—for JUNIOR.

CROSS, Seward Eugene
Civil Engineer 1—City, 104 S. Main, Wichita, Kansas—for JUNIOR.

DAVIS, Charles Hurd
Director Traffic & Planning Associates—Traffic & Planning Associates, Hickory, North Carolina—for MEMBER.

FERNANDEZ, Roger C.
Engineering Draftsman II—Metropolitan Dade County, Miami, Florida—for JUNIOR.

FRANKLIN, Jerome Curtis
Programing & Planning Engineer—Bureau of Public Roads, Santurce, Puerto Rico—for ASSOCIATE.

GALANIS, James G., Jr.
Traffic Engineer—County Road Department, San Bernardino, California—for ASSOCIATE.

GRAYSON, David Duayne
Traffic Engineer—City of Vernon, California—for ASSOCIATE.

GUTHRIE, George Phineas, Jr.
Research & Rural Intersection Studies Engineer—Bureau of Traffic, Ohio Department of Highways, Columbus, Ohio—for ASSOCIATE.

HASHMI, Tajammal H.
Deputy Consulting Engineer—Dentral Road Organization, Communications & Transport Division, Government of Pakistan, Karachi, Pakistan—for MEMBER.

HOWE, Robert Theo.
Associate Professor of Civil Engineering—University of Cincinnati, Cincinnati, Ohio—for ASSOCIATE.

JOHNSTON, Gerald Hobbs
Assistant Route Analysis Engineer—Ontario Department of Highways, Traffic Section, Toronto, Ontario, Canada—for JUNIOR.

LAVIOLETTE, Leo Edward Walter
Assistant Traffic Engineer—Corporation of the City of Ottawa, Ottawa, Ontario, Canada—for JUNIOR.

LINSEMAN, Kenneth George
Traffic & Streets Engineer, City of Kingston, Ontario, Canada—for JUNIOR.

MacDORMAN, Littleton Corbin
Location Engineer—Buchart Engineering, 55 South Richland Avenue, York, Pennsylvania—for JUNIOR.

MARTINEZ, Renalto Gilbert
Highway Designer—New Mexico State Highway Department, Santa Fe, New Mexico—for JUNIOR.

McNEIL, Donald III
Assistant Traffic Engineer—Donald M. McNeil, Consultant Engineering Services, Pittsburgh, Pennsylvania—for ASSOCIATE.

MENKE, Fred H.
Assistant Regional Planning & Research Engineer—U. S. Bureau of Public Roads, Hagerstown, Maryland—for ASSOCIATE.

NEVE, James Perry, Jr.
Engineer of Geometric Standards—Michigan State Highway Department, Lansing, Michigan—for JUNIOR.

PARMENTER, George Kent
Acting Assistant Traffic Engineer—County of San Bernardino, San Bernardino, California—for JUNIOR.

REDFORD, Alex J.
Civil Engineer—Whipple, Murphy, Pearson & Associates, Seattle, Washington—for JUNIOR.

RUSHING, James Ben
Traffic Engineer—City of Chattanooga, Tennessee—for JUNIOR.

SCHELANDER, Oscar Edward
Associate Highway Electrical Engineer—California Division of Highways, Fresno, California—for ASSOCIATE.

SETTEDUCATO, Nicholas M.
Associate & Project Manager—Edwards & Kelcey, Engineers & Consultants, Newark, New Jersey—for ASSOCIATE.

SHERIDAN, Richard Brinsley
Assistant Research Engineer—Institute of Transportation and Traffic Engineering, University of California, Los Angeles, California—for JUNIOR.

SMITH, Orville Alden
Traffic Field Operations Supervisor—California Division of Highways, District X, Stockton, California—for ASSOCIATE.

STOVER, Vergil G.
Automotive Safety Foundation Fellow—School of Civil Engineering, Purdue University, Lafayette, Indiana—for JUNIOR.

SULLIVAN, Thomas Darcy
Junior Traffic Engineer—Barton-Ashman Associates, Inc., Evanston, Illinois—for JUNIOR.

VEST, Thomas R.
Traffic Technician C—Virginia Department of Highways, Richmond, Virginia—for JUNIOR.

WEBER, Allen L.
Design Engineer—City Department of Traffic, Los Angeles, California—for JUNIOR.

WERLE, Armand E.
Director of Public Works—City of Walnut Creek, California—for ASSOCIATE.

WILKES, John Ballingal
Planning Engineer—Ontario Department of Highways, Toronto, Ontario, Canada—for ASSOCIATE.

WILLIS, Charles Louis
Traffic Engineer—Kentucky Department of Highways, Frankfort, Kentucky—for JUNIOR.

WOGLOM, James Russell
Assistant Director & Traffic Engineer—Morris Knowles Inc., Pittsburgh, Pennsylvania—for ASSOCIATE.

Applications for Transfer

DANIELS, Jack A.
Engineer II (Traffic)—City Traffic Engineering Dept.; Fort Worth, Texas—for ASSOCIATE.

HENRY, Ellis C., Jr.
Traffic Commissioner—City Traffic Division, City Hall, Room 327, St. Louis, Missouri—for MEMBER.

JOHNS, Kenneth B.
Director, Division of Traffic—Kentucky Department of Highways, Frankfort, Kentucky—for MEMBER.

KOHN, Melvin J.
Assistant Operations Manager & Traffic Engineer—New Jersey Highway Authority, Red Bank, New Jersey—for ASSOCIATE.

MANNING, John Ignatius
Director of Traffic & City Planning—City of Schenectady, New York—for ASSOCIATE.

MILLER, John Vinton, Jr.
Traffic Engineer—Richardson, Gordon & Associates, 3 Penn Center Plaza, Philadelphia, Pennsylvania—for MEMBER.

NADON, Joseph Donald, Jr.
Traffic Engineer—City of El Paso, Texas—for MEMBER.

SAWHILL, Roy B.
Associate Professor of Civil Engineering—University of Washington, 121 More Hall, Seattle, Washington—for MEMBER.

TRAVERS, Warren
Associate & Chief Traffic Engineer—Edwards & Kelcey, a Williams Street, Newark, New Jersey—for MEMBER.

WILLIAMS, Robert Carroll, Jr.
Director of Traffic Engineering—Traffic & Planning Associates, P. O. Box 1691, Hickory, North Carolina—for ASSOCIATE.

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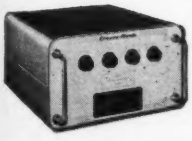
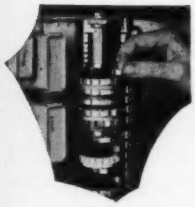
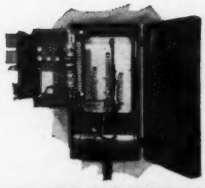


COMPLETE RANGE OF TIE-IN and Modifying Accessories provides all operations called for by engineers coping with today's traffic complexities. (All are compatible with existing systems.)



CAMSHAFT CONSTRUCTION reduces number of relays to *minimum* . . . permits a wider range of modifications before resorting to special accessories . . . without changes in timer or wiring.



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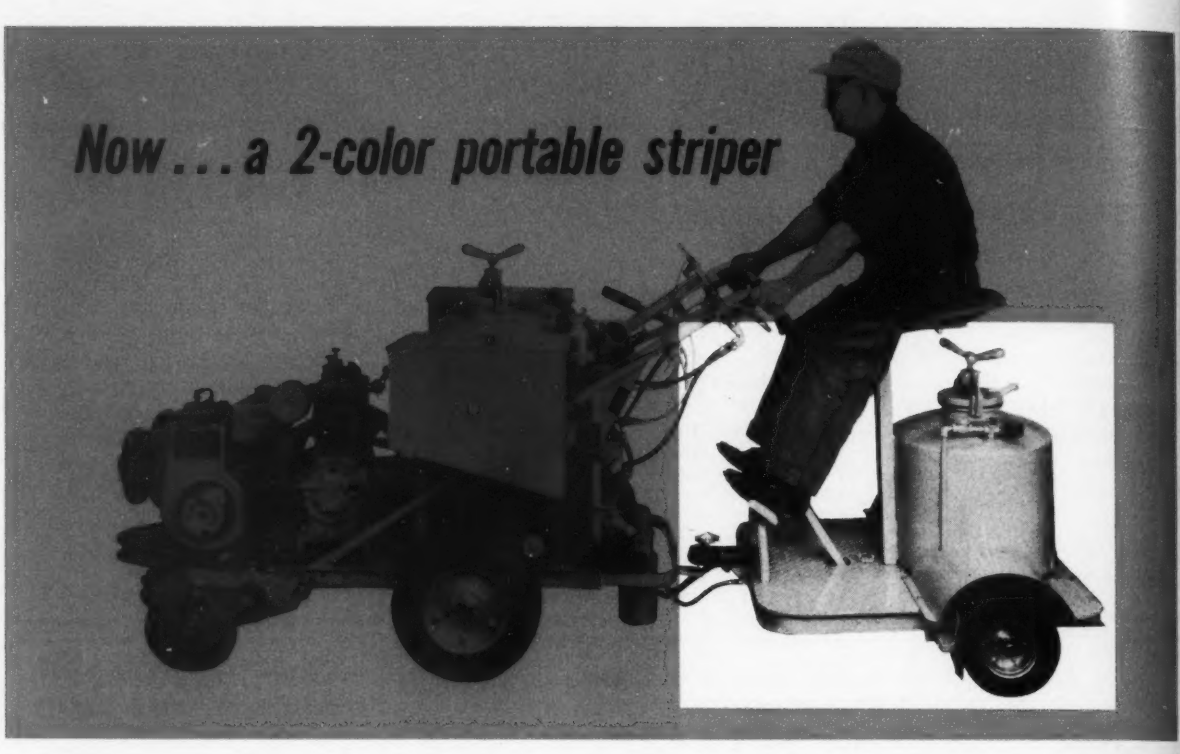

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